A PRIMER OF TROPICAL HYGIENE

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Royal Sanitary Institute

Presented by

The Author.

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PREFACE

BY

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THE subject of popular instruction in Tropical Hygiene is now being taken up as an important feature of the work of the College of Ambulance, Vere Street, London, and Colonel Blackham's Primer seems to me well adapted for the requirements of Europeans proceeding for service in tropical and sub-tropical countries.

This book has attained great popularity with both Europeans and Indians throughout the Indian Empire as five large Editions in English have been exhausted in as many years and translations into the various Indian vernaculars have been made and widely circulated.

The Primer deserves to be more widely known outside India as its teaching is not merely adapted to that Empire but to our many colonies and dependencies situated inside or near the Tropics.

I am using Colonel Blackham's volume as the textbook in Tropical Hygiene at the College of Ambulance, and consider that it should form part of the outfit of every person taking up an official or commercial appointment in a warm climate.

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THE COLLEGE OF AMBULANCE,
VERE STREET,
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CHAPTER I.

THE COMMUNICABLE DISEASES OF THE TROPICS.

SANITATION has been defined as a science which has for its object to make growth more perfect, decay less rapid, life more vigorous and death more remote.

The most important diseases, *i.e.*, the diseases which cause the largest loss of life in India, are :—

1. Malaria.
2. Cholera.
3. Dysentery.
4. Small-pox.
5. Plague.
6. Tuberculosis.
7. Malta Fever.

The causes of these diseases, as of all others, are best considered under two headings :—

1. The predisposing causes.
2. The exciting causes.

1. *The Predisposing Causes.*—The predisposing causes of the maladies mentioned above deserve special notice, as they also cause practically all the other ills that mankind is liable to in India and countries with a similar climate :—

1. Impure air.
2. Impure water.
3. Uncleanliness and untidiness of the dwelling house and its occupants.
4. Pollution of the soil round dwellings.
5. Errors in diet.
6. Fatigue and exposure.

These various causes will be referred to in detail subsequently.

Some of them, such as impure air and unclean surroundings, tend to produce an unhealthy or feeble condition of the body which deprives it of the power of resisting disease. Persons in perfect health can, and do, resist the growth of most germs, whereas if their vitality has been lowered by these or other causes (such as irregularity in work, sleep or meals or improper clothing), they are liable to "catch" any disease to which they may be exposed.

Other causes, such as pollution of the soil, produce a centre of possible infection which, when in the vicinity of houses, is dangerous to the occupants.

2. *Exciting Causes.*—The actual exciting causes of most diseases are living germs, growing in the tissues of the body. Nearly all these germs are minute vegetables or fungi, but a few diseases, such as malaria and kala azar, are caused by minute animals, All these germs are much too minute to be detected with the naked eye, but they can be seen with the aid of a microscope.

Germs are introduced into the bodies of human beings by the following means :—

1. Water.
2. Food.
3. Air.
4. Dust.
5. Flies and other biting insects.

It is by protecting the body from these sources of infection that we are able to limit many, if not

all, diseases. The methods adopted will be discussed later in detail. They may be said to consist, generally, in the prevention of the spread of microbes and their destructiou by various natural and chemical agents, *i. e.*, in the process which we generally term disinfection.

Malaria.

Malaria is such an all-important disease in India and similarly situated countries, that a chapter (Chapter II) is devoted to it alone.

Cholera.

Cholera is one of the most dreaded of tropical ailments, but there is nothing mysterious about it. It is easily recognised by the fact that the patient passes copious colourless stools which look like the water in which rice has been boiled, is very collapsed, suffers from cramps in the calves of the legs and is unable to pass water. It is an infectious disease, the outcome of filth and filthy habits, and easily preventible by a due recognition of this fact. The disease is caused by a minute germ which is taken into the system, usually in water, but often in contaminated milk or other food. It not only lives but multiplies with amazing rapidity in water, especially if it be muddy. The habit of the natives of India of frequenting tanks and river banks in order to obtain water for washing their persons after going to stool is responsible for the contamination of water

with microbes and the subsequent dissemination of the disease, for recourse is had to the same rivers and tanks for the washing of mouths and the cleaning of teeth. The germ may also pass directly into food through careless handling, when cooking, serving or sharing food, by servants or members of the family with unwashed hands or with hands washed without disinfectants in contaminated water ; or again through cloth soiled by choleraic excretions being used for straining cooked food. In all countries like India wherever a safe water-supply has been provided and efficiently guarded against pollution there the disease has been practically stamped out. Where cholera is prevalent persons who suffer from indigestion, especially looseness of the bowels, are comparatively liable to contract it.

This may be due to the inability of the disordered digestive juices to destroy the germs when they reach the stomach and before they pass into the bowels and suggests the necessity of avoiding uncooked vegetables, unripe or over-ripe fruits and articles of diet likely to upset the stomach.

The essential measures for protection against this, the most dreaded and the most easily preventible of all tropical diseases, are :—

1. A pure water-supply.
2. Clean food.
3. Efficient conservancy and disinfection of the stools.
4. Personal cleanliness.
5. Avoidance of raw or over-ripe fruits, raw corn and vegetables.

6. Isolation of the sick.
7. Careful disinfection of all clothing or other articles which have come into contact with a sick person.
8. Banishment of flies.
9. Clean houses and clean surroundings.

An important point to remember is that cholera stools must never be disposed of by throwing them on the ground; they will quickly dry and pass into the air as dust, but that dust is still laden with germs which for some time are able to revive and recover their deadly power as soon as they are moistened by water or the saliva of the human mouth. Cholera stools should always be burnt or buried where they cannot contaminate the water-supply.

It is highly dangerous to others to wash linen soiled by a cholera patient in a river, tank, well or *baori*; soiled linen should, if possible, be burnt. To rinse out the mouth with water liable to contamination by a person suffering from diarrhœa is highly dangerous.

Dysentery and Diarrhœa.

There are many types of diarrhœa, and at least two different kinds of dysentery, but the two points to be emphasized, and which are very little understood by Indians, are that dysentery is an infectious disease, and that diarrhœa, if allowed to run on, may develop into a serious disease.

Diarrhœa.—The chief *predisposing causes* of diarrhœa are :—

1. Chills.
2. Overcrowding.
3. Dirty surroundings.
4. Bad or ill-cooked food.
5. Foul water (*vide* Chapter IV.)

Germs are present in the intestines of all animals and have the power of setting up irritation of the bowels, the chief symptoms of which are diarrhœa and colic.

Water from the vicinity of a burial-ground is pretty sure to be harmful ; and "brackish" water, that is, water containing salt, is very likely to cause diarrhœa.

Besides predisposing to the condition, ill-cooked and badly chewed food, or unripe or decaying fruit, may be the direct or exciting cause of an outbreak of diarrhœa.

Flies play an important part in the transmission of this and other diseases, as will be shown in Chapter IX.

Another exciting cause of diarrhœa in children is an imperfectly cleaned feeding bottle. Feeding-bottles should be washed immediately after use in boiling water ; otherwise they are extremely dangerous.

Dysentery.—Dysentery is a very serious disease caused by microscopical parasites. It is recognised by the fact that the patient passes, with great straining, stools consisting chiefly of blood and slime.

It is now well known that there are two distinct varieties of the disease. One is due to a minute animal, whereas the other is due to a large group of vegetable fungi.

Both varieties of the disease are characterised by the presence of "sores" in the intestine.

The type due to the vegetable germs is usually acute in character and is the form which is rapidly fatal.

The form due to the minute animal usually takes on a chronic character. The minute animal finds its way to the liver and causes destruction of portions of it ; pus or matter forms, and what is known as abscess of the liver results, a condition which is highly dangerous to life.

In order to escape from dysentery it is necessary to observe the following rules :—

1. Avoid chills and especially avoid wearing wet clothes.
2. Avoid overcrowding, *i. e.*, breathe pure air.
3. Eat only well-cooked and sound food.
4. Avoid salt meat, tinned foods, coarse *atta* and raw corn as they predispose to diarrhœa.
5. Drink only pure water. If in doubt as to its quality boil all drinking water.
6. Disinfect everything that passes from a sick person, and either bury or burn it. Never throw dysenteric stools on to the ground.
7. Disinfect by boiling or prolonged exposure to the hot sun all bedding and clothing which have been used by a patient.

8. Never eat with a person suffering from this disease, or in the same room.
9. Always wash the hands after attending to the patient, especially before eating.
10. Thoroughly lime-wash or "leep" with cowdung, or preferably with red mud, the room in which a person has been sick or died of this disease.
11. Lime-wash any room in which a person has been sick of the disease.
12. Keep your house and its surroundings clean and free from flies.

If you observe these rules, you and yours will never suffer from dysentery.

PLAGUE.

This disease is characterised by :—

1. High fever.
2. Delirium.
3. Great depression.
4. Collapse.

If the patient lives, bleeding may occur underneath the skin, forming the so-called plague rashes.

In about twenty per cent. of cases enlarged glands appear on the second or third day in the armpit or groin. These constitute the buboes from which the disease derives its name.

In a small proportion of cases the lungs are affected and the disease is almost indistinguishable from ordinary pneumonia. In a still smaller percentage the disease takes the form of acute blood-poisoning.

The disease is caused by a bacillus, *i.e.*, a minute fungus.

A plague epidemic amongst human beings is invariably preceded by an outbreak of the disease amongst the local rats, and many dead rats are found in the streets and houses. After the discovery of the plague bacillus this rat disease was shown to be true plague and it has been subsequently proved that :—

1. Bubonic plague in man is entirely dependent on the disease in the rat.
2. The infection is conveyed from rat to rat and from rat to man solely by means of the rat-flea.
3. A case of bubonic plague in man is not, in itself, infectious.
4. Insanitary conditions have no relation to the occurrence of plague except in so far as they favour the presence of rats.
5. Plague is usually conveyed from place to place by imported rat-fleas, which are carried by people on their persons or in their baggage. The carrier of the fleas may himself escape infection.

When a human being contracts plague what usually occurs is this.—The rats in the house first contract the disease. Then when they begin to die of it the remainder, as is their custom, at once desert the infected house, but they leave behind them their nests which are full of rat-fleas. These fleas contain plague bacilli owing to their having sucked the blood of infected rats. Presently they become hungry and, finding no rats to feed on, they bite the human inhabitants of the house and thus infect them with plague.

The measures therefore which are necessary in order to avoid plague oneself, and to stamp it out of towns and villages, are :—

1. Cleanliness and tidiness in the house, so that there will be no shelter behind which rats can construct their nests, and no food lying about for them to eat.
2. Houses so constructed that grain and other foodstuffs can be stored where it will be inaccessible to rats and not likely to attract them.
3. Discouragement of rats as domestic animals.

Besides the danger of disease there is the loss to the householder, for it has been estimated that a single rat will consume a maund of grain during its life.

4. Prophylactic inoculation, which should be resorted to as soon as plague appears in any locality in epidemic form. Becoming thus immune himself a man can safely attend to his plague-stricken friends and relations, because the bite of the flea no longer poisons him. Death from plague is, as often as not, immediately due to heart failure consequent on a patient being left to look after himself.

Enteric or Typhoid Fever.

Enteric is one of the most formidable diseases of the Tropics, not only on account of the amount of sickness and the number of deaths for which it is responsible, but because of the expensive sani-

tary measures necessary to prevent its spread. It is a disease characterised by continuous fever lasting for about three weeks. Diarrhœa in which the stools resemble pea-soup is occasionally present, but more generally the patient is constipated.

The microbe is conveyed by :—

1. Water or food (especially milk) which has been contaminated by either the stools, urine, or saliva of typhoid patients.
2. Dust.
3. Infected clothes.
4. Apparently healthy persons who are "typhoid" or "enteric carriers."

(1) (*a*) *Water*.—The spread of the disease by this means is detailed in Chapter IV.

(*b*) *Food*.—The microbe of enteric is usually conveyed to food or milk by flies. This point is again referred to in Chapter V.

(2) *Dust*.—Dust becomes infected from uncovered dejecta or soiled clothing. This is again referred to in Chapter III.

(3) *Infected Clothing*.—The dangers of infected clothing are given in Chapter VI.

(4) *Typhoid or Enteric Carriers*.—Up to a comparatively recent date the cause of countless outbreaks of enteric fever, under conditions where the water supply was good and food pollution out of the question, remained inscrutable. In the year 1906, however, it was shown that a female baker, herself apparently healthy, had infected every new employé at the bakery which she owned, whilst an apparently healthy female engaged in

the milk trade had been the cause of another outbreak of enteric.

These cases were rapidly followed by others in which it was shown that persons who had had enteric fever, dysentery or cholera, frequently harboured the microbes of the malady in their intestines for many years after recovery.

They had become what are termed "carriers" of the disease. The bacteria are passed with the dejecta in countless myriads at irregular intervals.

Under conditions of life where the water-carriage system of sewage disposal is adopted, these persons are harmless, *unless they have to do with food-snpplies.*

In the Tropics, however, such persons are a constant source of danger, as their dejecta are too often exposed to the action of the sun and flies. Entangled on the legs of flies or in the form of dust the microbes of disease from the bowels of these carriers gain access to water and food-supplies with the result that inexplicable outbreaks of the disease occur.

The fact that the dejecta of apparently healthy persons are often the source of the most potent danger is one which ought to be grasped by every-one; it is because of this fact that prompt and efficient disposal of refuse of men and animals is the very first essential to successful tropical sanitation.

As regards enteric fever, moreover, it is important to recognise the fact that it is not only the stools which convey infection—the urine and expectoration are equally dangerous.

The disease may be avoided by the same precautionary measures which we have laid down for dysentery, but there is an additional measure which is worthy of the greatest consideration. That measure is anti-typhoid inoculation.

The protection afforded against typhoid lasts for at least two years, but the resistance of the blood to the enteric organism remains as high as four times the normal for as long as six years.

It is not pretended that the method will absolutely protect against enteric, as vaccination will against small-pox, because enteric and small-pox are different types of disease.

One attack of small-pox is, practically, an absolute protection against another, but one attack of enteric, although it renders a second attack uncommon, is by no means an *absolute* protection. Anti-typhoid vaccine may be compared to quinine. Would any individual be justified in withholding quinine from the inhabitants of a malarial country? Similarly, as in this country every article of food and drink and every particle of dust inhaled is a potential source of enteric, the individual who withholds the weight of his council and advice in securing the wide adoption of a method of prevention which has the approval of every scientific mind in Europe and Asia must have a feeling which no one will envy him when he hears that one of his dearest friends has gone to hospital with enteric fever.

The fluid used for the purpose of inoculation is nothing more than a culture of the enteric germ sterilised by heat and disinfectants. It is no more

dangerous than any other stewed vegetable material, and as it is absolutely sterile and injected with every conceivable care it gives less trouble than ordinary vaccination.

The Under-Secretary of State for War stated in the House of Commons on March 1st, 1917 :—

"The admission ratio of typhoid fever amongst the troops in France who had not been protected by inoculation was 15 times higher than amongst those who had been inoculated, and the death rate was 70 times higher."

TUBERCULOSIS.

The disease was for a long time, like cholera, a mysterious malady, but thanks to the researches of the late Professor Koch we now know that there is nothing remarkable about it. It is caused, like cholera and most other diseases, by a minute fungus—called in this disease the tubercle bacillus.

This microbe is present everywhere, but though small, it does not pass invisibly from one individual to another, but is carried by tangible and visible dirt and dust.

It is therefore not necessary to isolate every consumptive in order to stop the spread of the disease.

Such a procedure would be outside the range of practical policy even in Calcutta alone, where there are over two thousand deaths from this disease every year.

All that is requisite is :—(1) to prevent the bacilli in the patient's sputum from reaching the

floors and walls, (2) to have both the latter well lighted and aired and exposed to direct sunlight at some time during the day, (3) to see that dust from the floors is not raised by sweeping so as to be inhaled into the lungs or to settle upon food, fingers or clothing, and (4) that children are not allowed to play upon floors which may be contaminated.

Tuberculosis of the lungs is one of the most important of all tropical diseases, and one of which the spread could readily be stopped if the public would only adopt the following rules in their daily life :—

1. Give up the practice of spitting.
2. In the case of sick men, make them spit into a disinfectant, such as carbolic acid solution (1 in 20), or cresol solution (two teaspoonfuls to a pint of water), or into an earthen pot full of ashes which can afterwards be burnt daily or hourly.
3. Avoid overcrowding.
4. Eat plenty of nourishing food.
5. Build houses so that sunlight can enter.
6. Keep windows and doors open even in the coldest weather, especially at night, when many individuals are crowded into one room.
7. Diminish dust.
8. Banish flies.
9. Never drink unboiled milk, and be very careful that only milk from healthy well-housed cows is consumed.

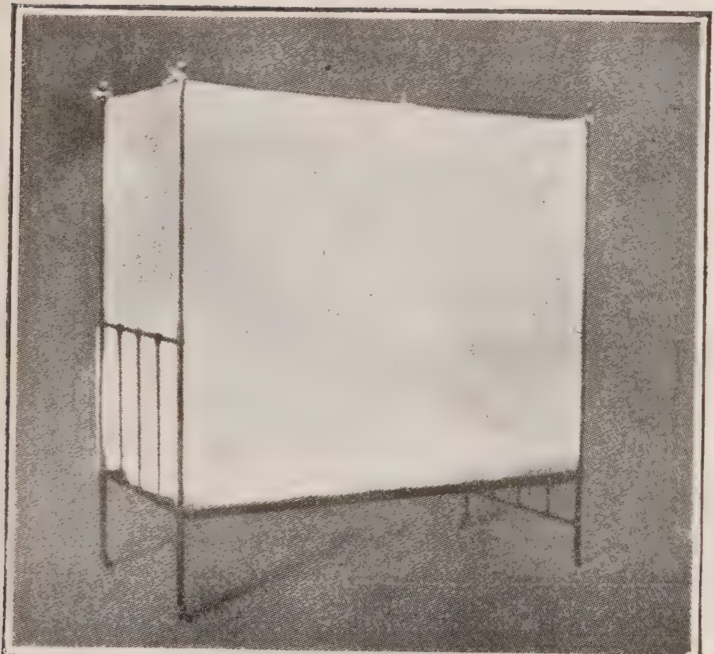
Small-Pox.

Small-pox has pursued the human race all over the world with the utmost tenacity and malignity.

So dreaded and so inevitable did the disease appear in ancient times that small-pox *inoculation* was introduced with the idea of contracting for an inevitable attack by voluntarily having one which would be so mild that life would hardly be endangered.

The disadvantages of this practice are that persons undergoing the operation have to subject themselves to a preparatory course of treatment and to various arduous restrictions for many days after the operation. When practised in England, the preparatory treatment lasted a month and medical attendance was required for five or six weeks after the operation.

The term *vaccination* means the intentional inoculation with the matter of *vaccinia* or cow-pox, and contrasting the results of small-pox inoculation with those of this newer method of protection we may say while inoculation produces in the individual operated upon an attack of human small-pox which is dangerous not only to the inoculated person but also (from its contagiousness) to everyone around him, vaccination produces a mild local disease which effectually protects the vaccinated individual against human small-pox and is, moreover, entirely without danger to him and (not being contagious) entirely without danger to others. Again, while small-pox inoculation tends—at



A Mosquito Net Properly Applied.

any rate in crowded communities—to increase the prevalence of the disease, vaccination reduces the prevalence and mortality of small-pox in a remarkable manner. Obviously, therefore, vaccination is the better practice as it possesses none of the disadvantages of inoculation and many advantages not possessed by that measure; it has therefore taken the place of the older practice almost throughout Europe and the Tropics generally; but there are still unfortunately some areas in British India where inoculation is still carried on.

The results already effected by vaccination in the Tropics generally, and in India in particular, are such as justly afford reason for enthusiasm and pride, but much still remains to be done before we shall be within measurable distance of completing the emancipation of the people from the horrors of small-pox. Vaccination should be done within the first few months of childhood, as soon as the child is strong enough. The part vaccinated should be left alone or covered with a piece of clean lint or linen. The practice of applying cowdung to the pocks is dangerous.

MALTA FEVER.

Many persons, on account of the difficulty of obtaining cows' milk whilst in camp, are in the habit of taking goats with them and drinking the milk of these animals, especially with their tea. Goats' milk when used for this purpose is almost invariably milked at the time it is required and served fresh.

It is practically never boiled, most people being under the impression that the fact of mixing it with hot tea renders boiling unnecessary. This is a fallacy, as the mere act of mixing contaminated milk with hot tea is not sufficient to kill all germs that it may contain. Goats' milk very frequently contains the germs of a serious disease which is known as Malta fever. This is ordinarily a disease of goats in the same way that plague is ordinarily a disease of rats, and human beings only suffer from it accidentally. In the case of Malta fever the channel of infection is the milk of the goat. The reason why this disease is called Malta fever is because it was first detected in Malta, where it caused great ravages amongst the British troops stationed there, and where its actual causation was carefully worked out. We now know that it exists practically all over the world in tropical and sub-tropical countries, and it has been discovered in the West Indies, Africa, Egypt, India, China, etc. In India it is chiefly found in the Punjab, but cases have been recorded in other parts of the country. The main characteristic of Malta fever is its long duration. It is a prolonged fever, in which the febrile attacks alternate with periods when the patient's temperature is normal or sub-normal, and this alternation of febrile and non-febrile periods may last for many months. For this reason it is sometimes called "Undulant fever." Though few patients die of the disease; it causes grave anæmia and is associated with profuse sweats and severe pain in the back and lower limbs. So far as we know at present, no remedy has much

effect upon the course of the disease, and quinine is absolutely useless. It is most important, therefore, to prevent infection. From what has been said above as regards the way in which the disease is conveyed, it is obvious that the only safe course is either to give up goats' milk altogether or else to see that it is carefully and thoroughly boiled before use. Of the two alternatives, the author recommends the former, because one can never be absolutely certain as to the actual boiling of the milk. Moreover, nowadays, when it is possible to obtain excellent unsweetened and uncondensed milk in tins, there is no necessity whatever to run the risk of using goats' milk. If, however, goats' milk is used, then all the precautions noted under the head of Milk in Chapter V should be strictly observed; everything that has been said as regards the importance of boiling milk in order to prevent the risk of tuberculosis applies with equal force to goats' milk and Malta fever.

CHAPTER II.

Malaria, Kala Azar, and Sand-Fly Fever.

Malaria has prevailed all over the world since the earliest times, but it baffled all treatment until A.D. 1640, when the Spanish conquerors of Peru were told by the natives that a certain bark which grew on the slopes of the Andes was a sovereign remedy for the disease. This bark was brought to Europe by a Spanish Countess and in honour of her was called *Cinchona.* Its active principle is the drug we know as *Quinine.*

No further progress was made till comparatively recently when a French Army Surgeon discovered certain minute parasites in the blood which were subsequently shown to be the cause of malaria.

It was observed that the presence of these parasites in the blood was invariably associated with mosquitoes, and acting on the suggestion that the disease was propagated by them, mosquitoes which had bitten malaria-stricken patients were brought to England. It was found that a young doctor who had never been out of England and never lived in a malarious district, after being bitten by the infected mosquitoes developed a typical attack of the disease and the malarial parasites were found in his blood.

An anti-malarial campaign was then undertaken in Italy; and it was shown by practical experiments that by either (1) protecting the individual from the bites of mosquitoes, (2) exter-

minating mosquitoes, (3) or carefully treating all patients so that no opportunity may be offered to the parasite to enter the mosquito, the disease may be eradicated from a locality.

Prevention of Malaria.

Malaria is essentially a communicable disease, and a sufferer from the disease is a source of danger to the community. His disease is, of course, not transmissible as small-pox is through the air, but, provided mosquitoes are about, it is just as communicable through their agency.

If these facts are realised, it is obvious that the prevention of malaria may be secured by the ordinary methods of attack and defence :—

1. We may attack the mosquitoes in all stages of their development.
2. We may defend ourselves against them.
3. We may attack the parasite of malaria.

The Campaign against Malaria.

1. *The Attack on Mosquitoes.*—A campaign against mosquitoes may consist of :—

(*a*) An advance in force, or Government action, in the form of drainage and the organisation of mosquito brigades.

(*b*) Guerilla warfare, or personal efforts.

(*a*) *Advance in force.*—What we may call frontal attacks, or measures undertaken by Government, fall under two headings :—

1. *Permanent Measures* which consist in engineering efforts to deal with the breeding grounds once and for all by draining the land, filling up pools and ponds, rectification of water-courses, etc.
2. *Annual Measures* which consist in the action which is necessary year by year in dealing with small pools, rain-puddles, collections of water in gurrahs, fire-buckets, and such like, by what are called "mosquito brigades."

2. *Annual Attacks.*—Annual attacks on all collections of water which may prove possible breeding grounds are of great value in some districts, but they have their limitations in many parts of the Tropics.

These measures should be directed against :—

1. Water channels.
2. Tanks and pools.
3. Borrow pits.
4. Garden cisterns.
5. Disused wells.
6. Brick factories.
7. Grass farms.

These operations are best conducted by "mosquito brigades."

The work of these brigades is applicable to a very great variety of places in the Tropics—towns, collections of villages, cantonments, jails and all large industrial works and factories. They should always be organised where large gangs of labourers are employed on famine relief works, making of

railway embankments, roads, canal works, tea gardens, extensive building operations and other such undertakings. Their duties are simple, and half a dozen coolies under one headman can be taught their duties in a few days. A few gangs of such men working efficiently can prevent much malaria amongst thousands of labourers.

A mosquito brigade consists of from 10 to 20 or more workers under the direction of a skilled superintendent. The duties of the brigade are :—(1) To visit weekly every compound and fill in or drain all pools of water ; (2) to cover with a layer of kerosene oil or pesterine, or both mixed, all collections of water which are too large to be filled in or drained ; (3) to remove all broken tins, pots, bottles, etc., which can contain water and harbour larvæ ; (4) to instruct the inhabitants in the recognition of mosquito larvæ and in the methods of destroying them ; (5) to see that by-laws requiring that all fixed receptacles of water, cess-pools, etc., should be made mosquito-proof, are carried out, and to bring to the notice of the superintendent any householder in whose premises mosquito larvæ are frequently found ; (6) during the rains to drain off quickly all superficial collections of water which can last a week ; (7) to endeavour to drive adult mosquitoes out of dwelling houses, outhouses, and stables by fumigation with sulphur and other means ; (8) to make observations on the seasonal prevalence of mosquitoes and their habits, and on every matter regarding which increased knowledge might aid in the extermination of these insects.

In towns which extend over a wide area it is necessary, of course, to employ a number of brigades, the town being subdivided into areas of such size that every house and every possible breeding place of mosquitoes can be visited once a week by a member of a brigade.

Pesterine is a crude petroleum, and a four-gallon tin costs Re. 1-4 at Bombay. Its action is much slower than kerosene oil. One great advantage of it is that its colour tells us whether it has been properly applied. It is best used with an equal part of kerosene oil, and should be applied by means of an ordinary garden spray. In this way the liquid may, when necessary, be caused to find its way among grass and weeds which otherwise break the continuity of the film and allow larvæ and pupæ to escape.

The proportion in which it should be used is a three-gallon tin to every 10,000 square yards.

(*b*) *Guerilla Warfare.*—Guerilla warfare or personal efforts can be carried on by everyone. It simply consists of personally seeing to the defeat of isolated bands of the enemy which may invade one's house and compound.

We should *personally* see that the larvæ have no chance to breed in *our* environment, and may also attempt to drive out all adult mosquitoes which may lurk in nooks and crannies in our rooms from one year to another by fumigating our rooms with sulphur, or a less expensive material such as *gobar* or bazaar incense, or by spraying them with formalin or petroleum emulsion. Thick curtains of all kinds should be removed from all

living rooms in hot weather as they form favourite lurking grounds for mosquitoes. Clothes hung on pegs should be shaken out and placed in the sun at least once a week.

Large tubs with shrubs in them should not be kept near bungalows as they often contain larvæ.

Bath-rooms should always be very well lighted and airy, and the accumulation of water in catch-pits outside them should not be tolerated. Narrow-mouthed water vessels afford hiding places for mosquitoes, and unless carefully cleaned once a week may become breeding places.

Kitchen and servants' quarters require special attention.

Servants persist in keeping tubs, jars, and tins full of drinking water or sullage water, or manufacture pools by throwing dirty water on to the ground from the kitchen or their own quarters.

They have a special predilection for storing jam tins, sardine tins, bottles and other rubbish on the ground behind the kitchen and out-offices. Unless these and their surroundings are regularly inspected by the occupant of the bungalow and everything obnoxious of this kind cleared away, there will be plenty of places for mosquitoes to breed.

The occupier of a house in an Indian village or town should be held responsible for keeping his bungalow, as far as possible, free from mosquito-breeding conditions. It is obvious that no attempt at general sanitation in the way of drainage will be of any use unless householders observe the

rules given above. The marvellous success which has attended the efforts of the Americans in stamping out Yellow Fever in the West Indies is a useful object-lesson as regards the value of individual effort. Yellow Fever is a disease which, like malaria, is conveyed from man to man by a species of mosquito.

2. *The Defence against Mosquitoes and Sand-flies.*—The next method of prevention is defensive. We protect ourselves from being bitten. The measures we can adopt are :—

1. Mosquito-proof houses.
2. Mosquito nets.
3. Mosquito-proof clothes.
4. Agents to prevent mosquitoes biting.
5. Avoidance of certain colours.

1. *Mosquito-proof Houses.* — Mosquito-proof houses are largely used in America and Italy, and even in some parts of India. They are so costly as to be quite out of the question for general use.

2. *Mosquito Nets.*—These cost only a few rupees and must be our chief defensive weapons, and very powerful ones they are. They act in two ways :—(*a*) By protecting individuals from contracting malaria, and (*b*) by preventing patients suffering from malaria from becoming a source of infection to others.

The following rules must, however, be observed if a mosquito net is to be of real use :—

(1) The bed should be so broad as to leave a considerable space between the sleeper and the net. (2) If the bed is not wide, then the lower two feet of the net should be lined with calico;

this prevents mosquitoes attacking parts of the body which come into contact with the net during sleep. The sides and ends of the net must be inside the poles. (3) The lower border must be tucked well under the mattress, *not hanging on the ground*. (4) The net should always be let down in the afternoon and carefully inspected for mosquitoes or sandflies. A servant should be made responsible that it is in good repair and free from insects, and a fine inflicted for any insects found when the net is used. (5) The net should be stretched fairly tightly so as to allow air to flow through. (6) On getting into bed the interior of the net should be examined for mosquitoes that may have strayed in.

3. *Mosquito-proof Clothing.* — Such clothing should be worn in the malarial season as mosquitoes cannot bite through. In places where malaria is rife and virulent, the feet and hands should be kept covered after sundown and the favourite feeding ground of the mosquito and sand-fly, *viz.*, the legs and ankles and feet, should be well protected from attack.

4. *Agents that prevent Mosquitoes from biting.—Essential Oils*—Various chemical and mechanico-chemical agents have been used to apply to the skin of the face, neck, hands and other exposed parts to keep off mosquitoes, such as oil of eucalyptus, oil of rosemary, oil of aniseed, oil of lemon grass, kerosene oil and various patent washes.

The application of the *essential oils* wards off mosquitoes to some extent—one in great favour

in some parts of India is *lemon grass oil*. which is pleasant, harmless and procurable from all large chemists and bazaars.

The best application is kerosene oil and lanoline, but much as the mosquito abhors it, it is not proof against a hungry female.

With all these applications, as soon as the volatile part of the oil, or the essence of the ointment, has evaporated, mosquitoes will promptly begin their attacks. While, therefore, they are effective as protectives for the first twenty minutes or half an hour, they are of no use afterwards. They merely lull to false security, with the result that one may fall asleep to be assailed by anophelines, and possibly be infected by malaria while asleep. When female mosquitoes are decidedly hungry they will overcome their distaste for all such applications.

5. *Avoidance of certain Colours.*—Such colours as blue, dark red, brown and black are much more attractive to mosquitoes than white, grey, green, yellow and violet. The former colours should, therefore, be avoided, and preferably only white garments worn in malarial regions.

III. *The Attack on the Malarial Parasites.*—If our attack and defence on mosquitoes have failed, we have still in quinine a drug which, although it has no influence on mosquitoes themselves, is a powerful weapon against the little parasites of malaria which constitute the weapons of the mosquito in her warfare against man. Quinine will not only cure malaria but it will prevent it. We can by taking quinine bring about such a change in our blood that the parasites of malaria will

not grow in it, or, at least, will not thrive in it. The Imperial Malarial Conference considered that the best plan of using the drug for prevention is to take five grains every day (preferably in the evening) during the malarial season.

When taken to cure malarial fever, quinine should be taken a couple of hours before the return of the fever is expected.

Whenever quinine is used to prevent or cure malaria it must be used regularly and in sufficient quantity, as it is a well recognised fact that when taken irregularly, especially in small doses, it seems to do more harm than good.

This irregular use of quinine is responsible for the statement that quinine has no influence in checking malaria, whereas it is not the fault of the quinine but the manner in which it has been taken. Another reason for its falling into disrepute is its use in fevers which are not malarial in their nature, such as the following :—

Kala Azar.

For many years it was believed that a disease associated with great enlargement of the spleen, progressive weakness and anæmia and a perceptible darkening of the complexion, was the result of repeated attacks of malaria, and it was called "chronic malarial cachexia." This disease is specially known in Assam, Madras and the Dooars as *Kala Azar*, where it is the cause of much sickness and mortality amongst the coolies on the tea plantations. We now know that it is caused

by a totally different parasite from the one which causes malaria; also that quinine is particularly useless; and that the agent which conveys infection from one human being to the other is not a mosquito, but is the bed-bug. General sanitation, therefore, and the systematic destruction of bugs are the only weapons which, in the present state of our knowledge, can be regarded as being of any avail.

Sandfly Fever.

The sandfly is one of the pests of the Indian plains, and new-comers to districts where it abounds suffer from short febrile illnesses when the sandfly makes its appearance.

Since it has been shown that sudden outbreaks of a short fever, unlike ague, prevail every spring, summer and autumn in various parts of India, and that these attacks only occur where sandflies abound, it is pretty clear that many short febrile ailments are caused by the invisible virus carried by the sandfly.

It is possible that a large amount of the so-called malaria of Indian Troops and the Indian Jails is really sandfly fever.

The insect has been found to propagate itself in the dejecta of lizards and wood-lice, and is only prevalent where walls and roofs are badly constructed and in bad repair, thus favouring the development of the indirect hosts of the insect.

The chief methods of prevention are:—

1. Good walls to houses.

2. Painting or distempering instead of white-washing walls.
3. Good floors and the disuse of matting.
4. Removal of old walls and ruins.
5. Formalin spray.
6. Removal of all old woodwork, and painting and varnishing of all doors, etc., yearly.
7. The use of a fine-mesh mosquito net.

CHAPTER III.

Air and Ventilation in Hot Countries.

If the air breathed is impure, the nourishment of the whole of the body is lowered, as air is as essential to life as food and water.

It is on this simple principle of physiology that all need of fresh air and, therefore, of ventilation is based.

To understand the subject it is necessary to know :—

1. The constituents of the atmosphere.
2. The chief sources of its impurity.
3. The amount of air space necessary.
4. Nature's agents for purifying the air.
5. Our artificial means of supplying the individual with fresh air.
6. The dangers of impure air.

1. *The Constituents of the Air.*—Fresh air consists of a mixture of gases, some water and a certain amount of solid matter in very fine subdivision. The chief constituent from the point of importance is oxygen, but, from the point of quantity, nitrogen.

Oxygen is a colourless, tasteless gas which burns up any material exposed to it, whilst nitrogen has no specific properties as a portion of the atmosphere, and merely serves to dilute the potent oxygen.

In addition to these two constituents, the air contains, in varying amounts, a third gas—Car-

bonic Acid—which differs from the other two in being poisonous if breathed in large quantities.

2. *The Chief Sources of Impurity of the Air are*:—

(*a*) Products of respiration.
(*b*) Products of combustion.
(*c*) Products of decomposition.
(*d*) Dust.
(*e*) Bacteria.

(*a*) *Products of Respiration.*—Respiration or the breathing of animals adds to the air the following:—

(1) Carbonic Acid.
(2) Water.
(3) Dead Tissues.
(4) Germs.

The average adult gives off about half a cubic foot of carbonic acid per hour, and oxen and horses about three times that amount.

It will be readily grasped from these facts how indescribably foul the air of Indian huts can become when half a dozen human beings and several animals are herded together in one small unventilated room.

(*b*) *Products of Combustion.*—The chief products of combustion which concern us are carbonic acid and carbon monoxide.

It is very desirable that everyone should appreciate the difference between these two gases. When one looks at a fire burning in an *angethi*, one is unconsciously witnessing the process of a chemical combination. The carbon of the wood, coal or charcoal is uniting with the oxygen of the air to form one of two chemicals, either carbonic

acid, a comparatively harmless compound which we consume in considerable quantities in aerated waters, or carbon monoxide, an active narcotic poison.

It is this latter gas which is the source of danger when an *angethi* is burned in a closed apartment. Cases of death due to charcoal fumes are not infrequent in bazaars, so that the poisonous gases given off by any kind of stove, and especially by a charcoal *angethi*, cannot be too widely known.

(*c*) *Products of Decomposition.*—The chief practical point in this connection is that decomposing vegetation produces poisonous and inflammable gases, so that the heaps of rotten leaves, etc., which are commonly seen outside a bedroom in India are things to be carefully avoided.

(*d*) *Dust.*—This is a source of impurity of the greatest importance in India. The following ingredients may be found by microscopical examination of ordinary bazaar dust :—

1. Bits of charcoal.
2. Bits of cotton and other fabrics.
3. Bits of skin.
4. Bits of insects.
5. Bits of hay and straw.
6. Dried sputum.
7. Dried bits of excrement.
8. Germs anchored on to all these various particles of matter.

The harmless-looking motes which we see dancing in the sunshine are therefore very frequently as dangerous as cordite and constitute not only an undesirable, but also a positively disgusting mixture.

(3) *The Amount of Air Space Necessary.*—This will depend on whether the room is to be used as a working place (as in a factory), or as a dwelling place only.

At least 1,000 cubic feet of air space should be allowed for each person occupying the room, *i.e.*, a space of 10 feet long, 10 feet wide and 10 feet high. The cubic capacity of a room is found by multiplying together the length, breadth and height of the room. In calculating the cubic space of a room it is necessary to deduct the cubic space occupied by furniture and to make allowance for the number of lamps generally used. The more lamps used, the larger must be the cubic space allowed for each person ordinarily occupying the room; and it may be taken as a rough average that every kersosene oil lamp burning in a room pollutes the air to the same extent as seven adults.

4. *Nature's Agents for Purifying the Air.*—They are :—

(*a*) Rain.
(*b*) The action of sunlight.
(*c*) The action of plants.
(*d*) Winds.
(*e*) Diffusion of gases and differences in temperature.

(*a*) *Rain* is simply a mechanical purifier; it washes the air. As it falls it removes all suspended organic impurities and absorbs some of the harmful gases.

(*b*) *The Action of the Sunlight* has the power of killing germs in the air and will be referred to later.

(c) *The Action of Plants.*—Plants absorb carbonic acid from the air and give off oxygen. Carbonic acid, which is so inimical to animal life, is indispensable to vegetable life. Animals *exhale* it, and plants *inhale* it, so that every tree in the crowded Indian city and every plant in the village garden transmutes it by the heat of the sun into blossom, leaf and stem, imprisoning the carbon and setting the oxygen free.

(d) *Winds.*—The winds tend to distribute the air, and thus by mixing the gases produce uniformity of composition.

They are splendid means of ventilation. They sweep impurities out of the streets, houses and every place where they can enter. A strong wind has often caused an epidemic of disease to cease suddenly by sweeping away the stagnant air containing millions of germs of disease and also by causing better ventilation of houses and streets.

When the wind passes freely *through* a room from one side to the other, it constitutes one of the best means of ventilation. Our houses should have windows and doors nearly facing one another so that the air may enter by those at one side of the room and escape by those at the opposite side.

When screens, purdahs or furniture block up the windows the wind cannot clean the air of the room properly. This blowing through of air, which we call "perflation," cannot, however, alone be exclusively relied on, as the winds change, often from day to day, or cease altogether for days at a time.

Another natural means of ventilation is by *Aspiration.* This means that the wind blowing over a hollow tube (such as the chimney of a room) sucks the air out of the tube. More air from below flows up to take the place of the air which has been sucked out, and so a constant current often passes from the room to the chimney. In this way winds act as great ventilation agents by sucking up the air from rooms. A fire burning in a fireplace with a chimney, helps greatly to ventilate a room. The fire heats the air around and in the chimney, the heated air rises up the chimney and colder air flows into the rooms to take its place.

Artificial Means of Supplying the Individual with Fresh Air.—Ventilation is the removal of impurities which collect in the air of inhabited rooms by fresh air from outside the rooms. In all systems of ventilation we must have an *inlet* by which the fresh air is supplied, and an *outlet* by which the foul air escapes.

In cold weather do not close up all windows and doors. Windows in India are often provided with jhilmils; when these are opened, air passes freely into the room.

Keep Windows and Doors open as much as possible Day and Night.—If a window has glazed sashes which can be moved upwards, open the lower one about 4 to 6 inches at the foot and close this open space with a wooden board. The air will enter at the space where the two sashes meet, and the air coming into the room will be directed towards the ceiling and no draught will be caused.

Never close a chimney up in cold or in hot weather, for at all times it acts as a ventilator ; more so of course when a fire is burning or when a wind is blowing over its top. Hot foul air rises towards the ceiling, therefore a space along the topmost ridge of the roof or between the top of the walls and the roof should be provided to permit its escape.

In most tropical houses there are so many doors and windows that there is no risk of bad ventilation if they are left open. If the doors and windows are covered with *chics* to keep out glare, heat, flies, etc., the ventilation will generally be quite good.

Cold air does no harm as long as the occupants of a house are warmly clothed.

The huts of the poorer classes in India are generally very badly ventilated as there are no outlets for smoke or foul air.

During hot weather, doors and windows should be left open at night. In the day time air finds its way in through the *chics* covering the doors. Where punkahs (or electric fans) are used, these do not increase the purity of the air. They only move the air in the room and do not draw in the air to any extent from the outside or drive air out of the room.

In moderately hot weather, doors and windows should be left open as much as possible, both day and night. The heat will do less harm than breathing the poisonous air of tightly closed rooms.

Cook-houses should have chimneys and be well ventilated, otherwise food becomes tainted and unwholesome from the bad air.

During sickness good ventilation is more important than ever. Indian people generally close all doors and windows tightly in the sick room. This is the worst thing that can be done, as the patient is not only being poisoned by his own breath but by the breath of those waiting on him, and there is no condition in which a man requires good air so much as when he is ill. Only one, or at most two people, should be allowed to be with the sick person. When a person falls ill and is likely to be ill for even a day or two, he ought to be placed in the largest room in the house. He needs all the air he can get to help him to get well again.

The feeble health of the tropical native is largely due to the fact that several people sleep in the same small room with windows and ventilation holes tightly closed and with their faces covered with a sheet or blanket.

Indian ladies when travelling in dhoolies are often shut up so tightly that fresh air cannot get in, and after such a journey they often remain ill for several days on account of the poisoned air which they have been obliged to breathe.

Another point in relation to ventilation is the keeping of pets. Monkeys are very liable to consumption, and parrots suffer from a peculiar disease due to a bacillus closely allied to the typhoid or enteric organism. Monkeys have been shown to have infected their masters with consumption, and considering what is now known of their diseases, parrots cannot be regarded as altogether safe companions for man. Influenza is often contracted from the horse, and diphtheria is certainly spread by

various kinds of domestic pets, especially cats, fowls and pigeons. It must be remembered that bedding and clothing require to get their share of fresh air and sunlight just as much as the person who uses them.

6. *The Dangers of Impure Air.*—Air is the medium by which many diseases are conveyed. A defective or impure air supply may be a potent factor in the causation of the following ailments :—Indigestion, Bronchitis, Pneumonia, Weakness and Debility, and Heatstroke.

The people of India have not yet realised that a large proportion of the thirty-seven per thousand of the population who die annually in India die from spending a third of their existence in an impure atmosphere.

The fact that only half that number per thousand die annually in England is largely due to the fact that Englishmen appreciate the necessity of pure air.

The Dangers of Overcrowding.—There is very great danger in an overcrowded room.

(*a*) *Temporary Overcrowding.*—The bad effects of this are headaches, giddiness, fainting, and even vomiting and diarrhœa. If the overcrowding is extremely great, death may result.

(*b*) *Constant Overcrowding.*—Where people are constantly living in a bad atmosphere—in rooms too small and into which not enough air can come,—then their health rapidly deteriorates. This is shown by loss of strength; sleeplessness; loss of the desire for food; bad digestion; great feeling of unhappiness and of being unable to make any

prolonged efforts of body and mind. The sufferers become pale and "bloodless," partly as the result of "oxygen starvation," but chiefly on account of chronic poisoning by the foul air taken into their lungs.

Individuals whose vitality has been lowered in this way are very liable to contract other diseases, such as Consumption, Inflammation of the Lungs or Bronchial Tubes, Dysentery, Cholera, Plague, Small-pox, Typhus Fever, Measles, Diphtheria, as well as severe inflammation of the eyes called Ophthalmia which often causes total blindness. Children are especially liable to severe illness as the result of bad ventilation.

CHAPTER IV.

WATER AND WATER-SUPPLIES IN THE TROPICS.

PURE water for drinking purposes is not easy to obtain in the Tropics. The reason for this difficulty is mainly due to the pollution to which the water is subjected by the customs of the people and it is largely owing to this pollution that diseases caused by microbes and parasites are so rife. The drinking of impure and muddy water in a cool climate is liable to produce enteric fever, disturbance of the bowels and possibly worms, but the drinking of similar water in the Tropics is not only liable to produce those diseases but also cholera, dysentery, goitre, and many other parasitic affections. In hot climates even the external use of bad water for bathing purposes may cause oriental sores, guinea worms and other maladies.

All the world over man derives his water-supply directly or indirectly from the rainfall. Water as it condenses in the clouds from the gaseous state is absolutely pure, but by the time it reaches the surface of the earth in the form of rain it has become impure. Rain, as we have seen, is a purifier of the air and in performing this service to man it becomes itself impure. It washes undesirable gases and obnoxious solids in the form of dust out of the air, and either sinks into the soil or flows along its surface in streams.

Man obtains his supply from six sources which, according to their origin, are known as :—

1. Upland surface water, *i.e.*, water running down hillls in small streams in natural or artificially made lakes.
2. Rain water.
3. Ordinary surface water from cultivated land, such as land springs, streams and ponds.
4. River water.
5. Ground water, from wells and springs.
6. Distilled water.

A few details about these sources are necessary :—

1. *Upland Surface Water.*—A great many places in India obtain their supply from sources of this kind which are generally good ones as highland districts are usually sparsely populated and the land is accordingly poorly cultivated, so that the risk of sewage contamination is slight.

2. *Rain Water.*—In places where the rainfall is heavy and the springs are brackish, rain water often forms the chief source of supply.

3. *Ordinary Surface Water.*—This must always be regarded as dangerous as the presence of sewage is well-nigh certain. Ponds and tanks constitute a particularly dangerous source of water-supply which unfortunately is the only one obtainable in many parts of the Tropics.

4. *River Water.*—Such waters are constantly liable to pollution by men and animals. If it were not for the beneficent purifying work of oxygen, rivers in the Tropics would soon become little more than open sewers, but, fortunately, purifying processes go on actively in river water, and, if the

stream has many falls and eddies, the amount of oxygen dissolved in the water is so great that a moderate amount of contamination is soon got rid of. Moreover, there are various green plants continually at work giving off oxygen actively.

The oxidation process in rivers is a chemical process, started by bright sunlight. When the stream becomes too thick or muddy this process is checked or stopped, but even when this occurs there is still a purifying action going on, as a number of fish, shell-fish, cray-fish, microscopical animals, plants and bacteria live on sewage and other organic debris. Unfortunately these purifying processes in most rivers are not sufficient to cope with the quantity of organic material constantly poured in from source to mouth. The value of fish as purifying agents of water is undoubted.

5. *Ground Water.*—The water which falls on the earth and sinks into the soil returns again for the use of man as (*a*) wells, and (*b*) springs.

(*a*) *Wells.*—Wells are divided into three varieties :—Shallow, deep and artesian. The descriptive words are not used to indicate the relative depth of the well, but to deseribe the water-bearing stratum they tap. All shallow wells must be regarded as suspicious sources of supply.

It is essential that wells should be properly made. The well should be lined throughout or as far as possible with porous brick. The upper portion should be built or lined with stones. Around the mouth of each well a raised platform and drain should be constructed so that the water spilt in the vicinity of the well cannot return into

it, but flows away to a distance greater than the depth of the well. All wells should be emptied and cleaned out at least once every year, preferably at the end of the hot weather when the water is lowest. All broken vessels, mud, etc., should be removed, the sides of the wells scraped and quick-lime applied to the sides and bottom. When the water re-accumulates it should be treated with potassium permanganate, which is a pure chemical substance to which the strictest Hindu cannot object. One or two ounces of this substance should be put into a *dol* filled with water, stirred up, and the water then poured into the well and thoroughly mixed by repeatedly drawing up and pouring back *dols* full of water. If after half an hour a red colour is still present, enough potassium permanganate has been added. If the red colour has disappeared add one or two ounces more so as to produce a faint red colour lasting for 24 hours. If the permanganate is added at night the water will be fit to drink on the following morning. If still red it may have an unpleasant taste, but is perfectly harmless. All drinking wells should have covers.

Pumps should, if possible, be provided, as dipping of buckets provides endless occasions for contamination.

A radius of a hundred yards should invariably be left clear around a well. Wells near burial grounds, cess pools and unprotected latrines are liable to be contaminated and impure.

Indian villagers attend to the functions of Nature without the regard which Western races

commonly pay to the question of locality and consequently the soil in and about their villages is saturated with waste organic material. The water supply of tropical villages is only too frequently obtained from wells in which the water is within a few feet of the surface, so that in the rainy season every facility exists for the poisoning of whole communities, by cholera and other germs.

(*b*) *Springs.*—These are generally described as land and main springs. Land springs are often due to surface depressions touching the underground water level ; generally when the underground water reaches its lowest level such springs run dry.

Manifestly they receive their supply from very near the surface and are extremely liable to pollution.

Main springs are, however, generally good, but occasionally they, too, are doubtful sources of supply, and great care should be taken to investigate their immediate neighbourhood for surface derived impurities.

6. *Distilled Water.*—In rainless tracts and in regions where the rainfall is scanty, or where there are only salt lakes, the drinking water is frequently obtained by distillation. At Aden, where the wells are brackish and where rain may not occur for several years, the sea water is distilled and used for drinking purposes by the troops and European community.

So much for the sources of water. We must now consider how pollution may occur. This may take place :—

1. At the source.
2. During storage.
3. During transit or distribution.

1. *Pollution at the Source.*—In the Tropics it is a common practice for the women and children of the house to bathe in the tank from which the drinking water is taken. People also wash themselves and their clothes at wells and *baories* so that the dirty water flowing from their bodies and clothes flows back and contaminates the water of the wells and *baories*. This is a foul and most dangerous habit and is much to be deprecated.

Again, people wash their bodies and spit and wash their mouths in a tank or stream used for drinking purposes. They then collect the water for their cooking and drinking supply for the day quite close to the place they have just polluted. The dangers of this practice have already been pointed out.

2. *Pollution during Storage.*—There is no doubt that much pollution of water occurs during storage. It is very little use boiling water and then leaving it exposed to the contamination of insects and dust.

Drinking water should not be stored at all during cold weather unless the procedure is absolutely unavoidable, but in the hot season some simple means of storage for the purpose of cooling becomes an imperative necessity.

The ordinary Indian *surai* or *surahi* certainly cools water, but it has the disadvantages of being porous, it is not always kept covered and is difficult to clean thoroughly. When used it should be care

fully washed out and changed once a month. There is no doubt that this compulsory storage of drinking water for the purposes of cooling it during the hot weather is a fruitful source of pollution, and too much attention cannot be paid to it.

Water should be kept in *glazed chatties* or *gurrahs* and these should always be kept perfectly clean. The reason for this is that unglazed chatties take up dirt of all kinds by their pores, whilst in glazed chatties these pores are filled up and so cannot absorb dangerous substances. The glazed smooth surface is also much more easily kept clean than the unglazed one.

Galvanised iron or slate cisterns are the best means of storage, but they are usually impracticable for Indian houses on the score of expense.

All vessels used for storing drinking water should be kept covered so as to prevent dirt and dust from falling into the water.

3. *Pollution during Transit.*—This is another very common source of pollution.

Seeing that most water is, and must be, distributed by hand in India, this is a matter which demands constant care and supervision. *Mashaks* are frequently used in a most filthy state, whilst at all times sodden leather forms a favourite breeding ground for microbes of all kinds. Their use might be restricted to carrying water for other purposes than drinking and cooking. The *chagal* is just as dangerous unless frequently disinfected.

Broadly speaking, there are three methods for rendering impure water innocuous :—

1. *Physical.*— (*a*) By distillation.
(*b*) By boiling.
2. *Mechanical.* — By filtration.
3. *Chemical.*— (*a*) By precipitation.
(*b*) By use of germicides.

1. *Physical.*—(*a*)—DISTILLATION is, as we have seen, the chief means of supplying drinking water at Aden, but it is not generally used in any other Tropical district. (*b*) BOILING presents one of our oldest and best methods of preventing the noxious effects of bad water. Combined with some simple form of clarification or filtration, it is, if fuel is available, the best method of dealing with impure water with which we are acquainted.

Its disadvantages are :—

1. It is expensive because fuel is required.
2. The water becomes flat and insipid.
3. The water is heated and must be cooled before use.

2. *Mechanical.*—Filtration of some kind is a method which has existed in India from time immemorial as Manu directed that water should be drunk only after filtering through cloth. This recognises the necessity for purifying water though the method advised is useless. The *Susruta* also gives many good rules for the purification of water such as boiling and filtration. Filtration by sand and gravel is the one in use in some communities. Filtration of the crudest nature improves the potability of a water, and a simple device such as barrels fitted one inside the other with a good layer of gravel, sand, and wood ashes between them will not only clarify but actually purify

water very considerably. But this requires constant attention and change.

Filtration on a small scale for domestic purposes is now usually effected by two kinds of filters —the Pasteur-Chamberland and the Berkefeld. A few years ago there were on the market many kinds of filters constructed of many varieties of materials; chiefly from charcoal, asbestos, spongy iron and polarite. They have, however, gone out of fashion, having been found wanting in their action on bacteria. They do not sterilise the water or render it free from bacteria. It is because the Pasteur, and in a lesser degree the Berkefeld, possess this property that they have practically supplanted the others.

The readiness with which the filter candle—both Pasteur-Chamberland and Berkefeld—becomes blocked up when used with crude or pond water is a serious drawback to this type of filter, and leads sooner or later to the abandonment of its use. The candles should be either cleaned or replaced by new ones.

No filters of this type can be of great utility in the Tropics unless clarification by means of alum and a rough strainer is used as a preliminary to filtration. The Indian nut *Strychnos Poditorum* acts like alum.

3. *Chemicals.*—(*a*) *Mechanical.*—Alum and lime are used as mere mechanical purifiers: they have no specific action on the water. They simply form a precipitate which falls to the bottom, carrying with it most of the microbes and the organic impurities.

(*b*) *Germicidal.*—In the Tropics permanganate of potassium is chiefly used for this purpose.

The addition of permanganate to all water supplies is a valuable preventive of cholera. One to two ounces of permanganate will suffice for an ordinary well. The best plan is to place the chemical in a bucket, lower it into the well, draw up the bucket and pour into the well what has been dissolved, again lower and repeat this procedure until the whole of the permanganate has been dissolved. The treatment gives no unpleasant taste to the water; the main objection is the colour, which is apt to offend the fastidious, prejudiced and ignorant. Practical experience in recent cholera epidemics has confirmed the value of this method. The rule now adopted is to add enough permanganate to make the water distinctly red, so that it does not recover its normal colour for eight hours. If this is done in the evening the water is ready for use the next morning.

Bleaching powder has been very extensively used during the present war with the best results in preventing water-borne diseases. (*See* Chapter XII.)

The following points with regard to water-supplies should be committed to memory :—

1. With a few exceptions, all Indian well water is dangerous. There is often no other supply, but the fact should be kept in view.
2. Spring water is no guarantee of safety.
3. The sparkling appearance of some springs and shallow well waters is dangerously deceptive.

4. Heat is the most efficient means of sterilization.
5. Filtration of water cannot be regarded as being entirely reliable, but chemical sterilization with bleaching powder has proved satisfactory in the present war.
6. Domestic storage of water in the Tropics is most important and requires more supervision.
7. Indian customs lead to gross fouling of water in a quite unnecessary way.

CHAPTER V.

FOOD IN THE TROPICS.

THE foodstuffs used in various parts of the world are legion, but all the important constituents of them fall under one of the following five headings:

1. Nitrogenous compounds or proteins; including all varieties of meat, fish, fowl, peas, beans, and also cheese.
2. Fats.
3. Carbohydrates; including sugars, starches, and the various kinds of vegetable foods.
4. Salts.
5. Water.

In addition to these five essentials there is an important group of articles, such as tea, coffee and condiments, which are known under the comprehensive title of food accessories.

DIETARIES.

Putting on one side *air* and *water*, the necessity for which has been previously considered, in a sufficient diet there must be—

(1) *A protein constituent.*—That is, a food containing nitrogen—because nitrogenous or albuminous tissues form the essential frame-work of the body.

(2) There must also be salts, because these enter into the composition of all the tissues and fluids,

(3) Although fat can be formed in the body from proteins, such is not its usual mode of origin, neither could the whole quantity of fat that is required be obtained from this source. Therefore, *either a fat or carbohydrate* must be present in the food. There is no doubt that fat can be formed out of carbohydrates in the body, and the fats and the carbohydrates can replace each other in the food. The chief distinction between them is that whereas the carbohydrates are notably more digestible than the fats, a given weight of fat will produce more heat and energy than a similar amount of carbohydrate.

So far as the body framework is concerned the fleshy portions are derived from the proteins, and the salts are derived from the salts: the fats are derived not only from the fats, but also from the proteins and carbohydrates: while the carbohydrates are derived both from the carbohydrates and the fats of the food.

Good standard diets adapted to Englishmen and Natives of various parts of India doing various amounts of muscular work are constituted as shown in the Table on page 54*a*.

For hard work all the chief constituents of food may be increased. The sugars are the most valuable source of muscular energy. Any reduction in the diet of a man doing hard work should affect fats and carbohydrates rather than proteins. Age, sex, climate, season and personal peculiarity all exert a marked influence upon dietetic requirements.

It is estimated that 50 to 80 ounces of water are taken in all kinds of dietary, European and Indian.

Table of Dietaries for Europeans and Indians.

Class of individual.	Morning meal.	Midday meal.	Afternoon meal.	Evening Meal.
European (doing moderate work).	Bread and butter—Two slices. Eggs—Two.	Soup—One large plateful. Meat—One large helping with a little fat. Bread and butter—1 slice.	Milk—One glass. Bread and butter— Two slices.	Bread and butter—Two slices. Cheese—Two ounces.
Bengali (doing light work).	Boiled rice—3 chittacks. Dal or vegetables—A little. Or atta (flour) as a chuppati—2 chittacks. Salt—$\frac{1}{12}$ chittack. Vegetables and ghee—A little.	Rice—5 chittacks. Dal, fish or meat—1 $\frac{1}{2}$ chittack. Vegetables—2 chittacks. Ghee or oil—$\frac{1}{2}$ chittack. Salt—$\frac{1}{8}$ chittack. Condiments—$\frac{1}{2}$ chittack.	....	Exactly same as midday meal.
Bengali (doing hard work).	Same as Bengali (doing light work).	Rice—6 chittacks. Dal, fish or meat—2 chittacks Vegetables—2 chittacks. Ghee or oil—$\frac{1}{6}$ chittack. Salt—$\frac{1}{6}$ chittack. Condiments—$\frac{1}{2}$ chittack.	....	Exactly same as midday meal.
Native of Punjab, United Provinces of Agra and Oudh (doing light work).	Wheat or maize flour—2 chittacks. Rice—1$\frac{1}{2}$ chittack. Salt—$\frac{1}{12}$ chittack. Ghee and vegetables of each—Little quantity.	Wheat or maize flour—1$\frac{1}{2}$ chittack. Rice—2$\frac{1}{2}$ chittacks. Dal—1$\frac{1}{2}$ chittack. If a meat eater, meat or fish (instead of dal)—2 chittacks. Vegetables—2 chittacks. Ghee or oil—$\frac{3}{8}$ chittack. Salt and condiments, of each —$\frac{1}{2}$ chittack.	....	Exactly same as midday meal.
Native of Punjab, United Provinces of Agra and Oudh (doing hard work).	Same as above. ..	Wheat flour—3 chittacks. Or maize flour—3$\frac{1}{2}$ chittacks Ghee—$\frac{1}{4}$ chittack. Dal—1$\frac{1}{2}$ chittack. If a meat eater, meat or fish (instead of dal)—2 chittacks. Vegetables—2 chittacks. Salt and condiments, of each —$\frac{1}{2}$ chittack.	....	Exactly same as midday meal.

A man consumes daily about one-hundredth part of his weight of dry solid food and a three-hundredth part of water.

A vegetable dietary, unless carefully selected, usually contains insufficient nitrogen and an excess of carbohydrates. It is bulky, less digestible in the stomach, and less completely absorbed. The consistent vegetarian must either live on a diet deficient in protein or consume an excessive bulk of food. The adoption of the former course tends to diminish energy and tissue resistance, and the latter is likely to lead to derangement of the digestive organs.

Let us consider briefly the chief characteristics of articles of dietary :—

Nitrogenous Foods.

Meat.—Meat may be divided into two classes—red and white.

The latter are, as a rule, more digestible than the former. They contain, however, less nitrogen and are therefore somewhat less nutritious.

Fish.—Compared with meat, fish contains more water, less fat and less extractives. It is not specially valuable as a " brain food." The popular delusion on that point is grounded on the belief that fish is specially rich in phosphorus and that mental processes are dependent upon a full supply of this substance. There is, however, no justification for the statement either that fish is rich in phosphorus or that phosphorus is specially good for the brain.

Eggs.—Eggs constitute one of the best forms of nitrogenous food. The *white* part consists of what is known as albumen and a good deal of water. It is very digestible when raw or lightly cooked, but less so when the egg is hard boiled. The yellow part or the *yolk* contains fatty matter and phosphates. Eggs contain everything essential for the support of life except starch and sugar.

Milk.—Milk is derived, in by far the greatest quantity, from the cow. The buffalo, goat and ewe yield milks largely used in India which differ more or less in their composition from that of the cow, but the main characters of milk are the same in all mammals.

Physical characters.—Good cow's milk is of a full, opaque white colour, or with very slight yellowish tinge. It has a slight and agreeable odour and a sweet characteristic taste. Buffalo, like human milk, is bluish-white, whilst goat's milk has a peculiar odour resembling that of the animal itself.

Milk as an Article of Food.—Milk is most important as an article of food because it contains all the necessary food principles in a readily digestible form. Being designed for the nutrition of the rapidly growing young animals, it contains a very large proportion of water and a relatively large proportion of fat and proteid as compared with the carbohydrates constituent. It is not, therefore, a food suitable for the entire nutrition of the adult: but for the infant it is essential, whilst for the invalid and the elderly it is most valuable. One pint of average milk contains about 2½ ounces

of water-free food, whilst 1 lb. of meat contains about 4 ounces, but not all of this is perfectly digestible, as is the case with the whole of the solids of milk.

As a rule, milk should, before use, be boiled or pasteurised, *i.e.*, heated in a vessel placed inside another vessel containing water, the water being boiled for half an hour. The milk will be heated but not boiled and at the end of that time should be rapidly cooled; but this requires intelligent supervision, as many diseases, such as tuberculosis and enteric fever, are spread by contaminated milk. Boiled milk is said to be more digestible than fresh milk; it is, however, less palatable to most people and no doubt loses some of its nutritive value and some important salts in boiling, but whatever disadvantages boiled milk may have, they are far out-weighed by the security afforded by boiling against infection by the poisons of specific diseases so often present in unboiled milk.

Skim-milk and whey are not very nourishing, but are easy of assimilation, and are agreeable articles of food for invalids.

Cheese.—Cheese does not receive the amount of consideration it deserves in tropical dietaries. It is much better as a food than meat, and equal nourishment can be obtained from cheese as from meat.

It should be understood that the proper place for cheese is as a substitute for, and not as an appendage to meat. There is, however, one exception to this rule; it is correct to take a

small piece of cheese at the end of a meal for, paradoxical as it may seem, digestive reasons.

According to the old adage, cheese is a "crusty elf, digesting all things but itself," and in this there is an element of truth: all cheese contains elements of the character of ferments, which tend to set up a fermentative process in the food when it passes into the stomach and thus to promote digestion. But if cheese be taken in excess at such a time, the digestive action is paralysed and indigestion is the natural consequence, thus justifying the wisdom of our forefathers.

The cheaper cheeses are often more nourishing and more digestible than the expensive ones.

Fats.

Butter.—Good butter should be of a yellow colour, which deepens with the richness of the pasture. Cows kept in the house on hay or dry food give an inferior product, whilst buffalo cream always yields a dead white butter. Various substances are added to increase or produce the popular colour.

As an article of food, butter furnishes most people in easy circumstances with the principal part of their fatty food: it is extremely palatable and digestible when fresh and of good quality.

Ghee or clarified butter takes the place of butter in the dietary of most Indians. It is a wholesome and nutritious fat.

The Vegetable Foods.

These may be divided into six groups:—

Group 1.

Cereals.—These comprise the edible grains, such as wheat, oats, Indian corn, rice, etc. Of these, *wheat* is preferred as a food for the following reasons :—(1) The grain is easily separated from the chaff, which does not adhere to it, as in the case of barley, oats, etc. (2) The yield of flour is very large. (3) Owing to the peculiar constitution of wheat, light and spongy bread is readily made from it. (4) The proportion of the chemical constituents present render it well fitted for the general sustenance of man.

Bread can be manufactured in a variety of ways, but all methods aim at the aeration of the mixture of flour and water and subsequent cooking at a temperature of about 450 degrees F.

A good sample of bread should be well baked (not burnt), light and spongy, the crumb being well permeated with little cavities. It should be thoroughly kneaded, of good colour (white or brown), not acid to the taste, not bitter, not too moist. When set aside the lower part should not become sodden. A four-lb. loaf loses in weight about 1¼ ounces in 24 hours, about 5 ounces in 48 hours, and about 7 ounces in 60 hours.

This loss will vary with the temperature, draughts of air, etc.

Chapatti.—With the making of the *Chapatti* the people of India are familiar.

Oatmeal.—Oatmeal is the most nutritious of all cereals. It is very rich in fat. Oats prepared by rolling instead of grinding, and heated during the

rolling process are much more digestible and easily cooked than ordinary oatmeal. Prepared in this way, the cereal constitutes the much advertised preparations of oats, under various fancy names, which are so deservedly popular.

Gruel is prepared by boiling oatmeal in water or milk, and *porridge* is made by stirring the meal in boiling water and cooking until the compound becomes of the consistency of pudding. Owing to the fact that it is gulped down without chewing and therefore without allowing the starchy matter of the grain to become mixed with the saliva, porridge is not easily digestible. For this reason it frequently sets up flatulence and heart-burn. Oatmeal is also made into thin *cakes* by mixing into a paste with water and baking on an iron plate.

Meat Broth and *Vegetable Broth* are made by stirring the meal in the hot liquor in which meat or cabbage has been boiled. The product is not adapted to delicate stomachs.

Maize.—Maize or Indian corn is extremely nutritious: but it has some disadvantages. It contains much fat, and develops a disagreeable rancid flavour on keeping, and from its deficiency in gluten it is not adapted for making bread, unless mixed with wheat flour.

Cornflour is prepared from maize by washing away the proteid and fat by means of dilute alkaline solution, so that little but starch is left.

Rice.—This is the poorest of all cereals in proteid, fat and mineral matter. On the other hand, it it has fully 76 per cent. of starch. The starch has

the further advantage of being present in small and easily digested grains. When boiled, rice swells up and absorbs nearly five times its weight in water, while some of its mineral constituents are lost by solution. It is preferable, therefore, to cook it by steaming.

The nutritive value of rice is much impaired by its poverty in proteid and fat. Hence it is not adapted to be an exclusive diet, but should be eaten with other substances rich in these two elements, such as eggs, cheese or milk. Even as regards carbohydrates it would require about one pound and three ounces of rice to furnish the daily need of an active man. This would entail the consumption of about five pounds of cooked rice daily.

Group 2.

The Pulses.—This group consists of peas, beans and lentils.

In the fresh young green state these seeds are fairly easily digested, the cellular tissue is comparatively soft and they contain nutritious principles fairly easily reached by the digestive juices.

Peas and *Beans* are about equal in nutritive value. Both contain a good deal of sulphur, which is apt to give rise to uncomfortable flatulence.

Lentils, such as the various kinds of *dal*, are richer in phosphates than beans and peas, and contain less sulphur.

The group is rich in proteid—chiefly a substance called legumen, allied to the casein of cheese. It

is also rich in carbohydrates. Salts are fairly abundant, but phosphates are less so than in the cereals. Like wheat, the seeds are weak in fat and therefore require mixing with fats and carbohydrates to form a complete diet. Gram and cheese with potatoes is an example of a complete diet.

A mistake is very often made, chiefly amongst Europeans, in taking leguminous seeds as a vegetable with meat. They are flesh formers and are chiefly composed of vegetable proteid. *Dal* should therefore be used as a substitute for meat and it is best combined with rice, which we have already seen is deficient in proteids.

Group 3.

The Roots and Tubers.—These consist chiefly of carbohydrates, mostly in the form of starch, and very little other food material.

Potatoes consist of sugar, starch and a trace of proteid. When well-cooked, they are easily digested. The salts found in the juice of potatoes are a complete preservative against scurvy.

Beetroot, when young, is of some value as a food on account of the sugar it contains.

Carrots and *Parsnips* are of rather less value than beetroot.

Turnips are of little value as a food, and as liable to cause flatulence and dyspepsia. It is difficult to realise that an apparently solid object like a turnip really contains more water than a fluid like milk; yet such is the fact.

Group 4.

Green vegetables and fruits.

Green vegetables.—Consist of large quantities of water, much cellulose or fibre, and small quantities of sugar, gums, and allied bodies. The members of this group are chiefly valuable as flavouring agents, antiscorbutics, and natural stimulants to the action of the bowels. They have little or no nutritive value.

Cabbage contains much sulphur and is apt to cause uncomfortable flatulence.

Cauliflower is one of the most digestible of the cabbage tribe, and the flower contains nearly double the amount of protein found in common cabbage.

Onions are valuable as condiments. They contain a larger amount of phosphates than any other succulent vegetable, excepting asparagus, and have a slight laxative action on the bowels. They are also said to be very valuable for persons with a rheumatic tendency.

Fruits have low nutritive value, but are rich in vegetable salts: they are antiscorbutics of incalculable value.

Vegetables used in salads are valuable antiscorbutics. The salts are not lost by wasteful cookery. The uncooked cellulose greatly stimulates intestinal action, but it is apt to upset the digestion. Cholera, enteric and other diseases may readily be conveyed by uncooked vegetables. For this reason, only vegetables grown under personal supervision and

carefully washed before use should be eaten. Both on account of their indigestibility, therefore, and the danger of contracting cholera or enteric fever in this country, salad should, as a rule, be avoided.

Watercress is often grown in sewage water, and may spread enteric fever and worms. Even when obtained from the best sources it should be well soaked in strong salt and water, and then washed in boiled water before use.

Group 5.

Albuminous nuts.—The edible nuts, such as the walnut, are generally very rich in proteid matter and fat. They also contain some carbohydrates. The difficulty is that their digestion is not easy. This difficulty is diminished by grinding the nuts into a fine powder.

Group 6.

Edible Fungi.—This group comprises the mushroom, truffle, etc. They contain a fairly large amount of proteid matter, but a very great percentage of water, which makes them an extravagant food. They are difficult to digest.

Mastication or Chewing.

The adoption of the habit of thorough chewing of the food has a striking effect on appetite, making this more discriminating and leading to the choice

of a simple dietary, and in particular reducing the craving for flesh-food. The appetite, too, is beyond all question fully satisfied with a diet considerably less than is ordinarily demanded. The saliva or spittle has a digestive action on bread and starchy foods, but in order that it may be enabled to do its work, the food must not *only* be chewed but must be kept for a while in the mouth. Soft foods especially require to be acted on by the saliva, and so porridge, sujji, dhalia, bread and milk, rice, sago, tapioca, etc., although not requiring chewing to enable them to be swallowed whole, must remain for a sufficient time in the mouth. When the saliva is swallowed and reaches the stomach its powers of digestion are soon destroyed. The habit of hurrying over meals and bolting the food too rapidly is thus responsible for a great deal of indigestion. Flatulence of a distressing character is a common result of hastily bolting food. Indigestion may also be caused by neglect of the teeth, *vide* Chapter XI.

Beverages.

A certain amount of alcohol may be safely consumed as a heat-producing food. This amount is certainly very limited, not more than one or, at the outside, two ounces in twenty-four hours. When for some reason insufficient food is taken it is unnecessary, and when excess of food is taken the addition of alcohol does serious harm. Most people are better without it altogether.

In *childhood* alcohol as a beverage is most injurious: in *adult* life a strictly moderate amount with ordinary diet may be taken or not, but it is not necessary: in *old age, with failing strength and weight*, alcohol is most useful: *old age, with increasing weight and obesity*, alcohol is most injurious: it increases the tendency to fatty heart, kidney troubles, and apoplexy, with paralysis or sudden death.

Total abstinence in adult life is often necessary. Each man should test his self-control in the following way:—Having fixed a daily allowance (say one ounce of alcohol), he must make up his mind not to exceed it. If he cannot keep to the limit, total abstinence is imperative: each time the limit is exceeded his self-control is weakened and he is on the high road to a dreadful disease, dipsomania. Those who have once been victims to alcoholism and have broken the habit, must absolutely abstain for the rest of their lives.

Spirits neither give strength nor sustain against disease and are not protective against cold and wet. They aggravate rather than mitigate the effects of heat, and their use in excess is said to increase crime. The severest trials of the Tropics have been borne without them and there is no evidence that they are protective against malaria and other diseases.

Tea and Coffee.

Tea and Coffee.—Tea was evidently introduced by the Chinese, owing to the calamities arising

from drinking unboiled water. Deep well water is almost unknown in China and the shallow-wells and streams are so apt to become polluted, owing to the habits of the Chinese, that experience dictated the necessity of boiling the water. But boiled water being insipid, and the object of its being boiled not being evident to ignorant and thoughtless people, the water was "flavoured" by the leaves of the tea plant, a custom which has become widespread.

These leaves contain active principles which are stimulants to the nervous system. They act on the heart in small doses as a tonic, but in excessive or too frequent doses they make its action irregular and weak.

Excessive tea drinking often makes a person nervous and irritable.

Aerated waters.—These consist of water or a solution of salts with or without sugar and flavouring agents, aerated with carbonic gas. Carbonic acid gives a brightness to the water and a pleasant flavour. If carefully made in clean factories simple aerated waters are not injurious, but it is wrong to suppose that aerated are safer than plain waters. The mere addition of a little carbonic acid to the water does not kill off the germs it contains, and it is safer, therefore, in case of doubt, to drink plain water which you know to have been boiled rather than aerated waters from an unknown source.

Cooking.

The objects of cooking food are two-fold :—

1. *Aesthetic.*—To improve its appearance and to develop in it new flavours.

2. *Hygienic.*—To sterilise it to some extent and to enable it to keep longer.

It is an error to suppose that cooking increases the digestibility of food. This is only true with regard to vegetable foods. The digestibility of meat is diminished by cooking, although the increased attractiveness of cooked meat may render it indirectly more capable of digestion by calling for a more profuse flow of digestive juices.

Ordinary cooking or pickling affords little protection if meat is infected with the germs of specific diseases.

From what has been said it will be seen that there are many ways in which health may become affected by articles of food.

Diseases Caused by Food.

Overfeeding.—An excess of food, due to too large or frequent meals, may lead to an accumulation in the intestines, causing fermentation and dyspepsia, with constipation or ineffective diarrhœa. Gout, obesity, gall-stones and other conditions may arise from excess of food. Absorption of the products of putrefaction may give rise to a septic condition, marked with fever, furred tongue, fœtid breath, heaviness and possibly jaundice. Diseases of the blood may also arise from retention of waste products in the intestine.

Underfeeding.—Protracted insufficiency of diet is followed by wasting of the tissues. Adipose

tissue is naturally the first to suffer, and may be almost completely absorbed, the other tissues following mainly in the inverse order of their importance to life. Physical and mental weakness ensues, followed by a debilitated condition that powerfully pre-disposes to certain diseases, notably relapsing fever, phthisis, and pneumonia, and perhaps all infectious diseases. Diarrhœa is apt to occur, adding still further to the general emaciation and prostration. Ophthalmia, ulcers and skin diseases of various kinds are common, and any disease that may have obtained a hold upon the system is aggravated by the impairment of nutrition. Death ensues when the loss reaches about 40 per cent. of the normal weight of the body.

In conclusion, health may become affected by articles of food in the following ways :—

1. The essential constituents of diet may be deficient or in excess.
2. Poisonous substances may be derived from the vessels in which the food has been stored, as in the case of tinned provisions.
3. Injurious substances may be added by way of adulteration or by improper manufacture.
4. Certain kinds of shellfish are liable to be occasionally poisonous, even in the fresh state, and disease may be conveyed by oysters, green vegetables uncooked, etc., grown under unhygienic conditions.

5. Putrefactive changes may have commenced in the food and produce grave intestinal disturbance.
6. Poisonous substances, such as tyro-toxicon, may be developed, either as a result of fermentation or from unknown causes.
7. The flesh or milk of an animal suffering from certain specific or parasitic diseases, such as tuberculosis, may impart the disease.
8. Food, especially milk, may become infected by the virus of diphtheria, enteric fever, cholera or scarlet fever, from close contact with persons suffering from these diseases.

Disease in the individual, or more rarely idiosyncrasy, apart from disease, may render certain kinds of food, such as shellfish, injurious, which to ordinary persons are wholesome. Finally, there are certain food accessories, such as alcohol and tea, which may be injurious if used injudiciously.

CHAPTER VI.

CLOTHING IN THE TROPICS.

(*a*) *For Europeans.*

THE principal use of clothing is to assist in the maintenance of animal heat by affording protection against the changes and inclemencies of the weather, and generally by adding to bodily comfort.

We obtain all our clothing from a few animals and birds, a single insect, a couple of small plants and several varieties of grass.

Animals yield us wool, furs, and leather: birds yield us feathers: the silk-worm provides us with silk: whilst the cotton and flax-plants and several grasses provide us with the remainder of our clothing materials.

Wool.—Wool forms the natural covering of animals in cold and temperate climates. It owes its value to the fact that it contains an oil or fat, and that, when woven into cloth, it has numerous interstices which imprison air and prevent heat passing through it; hence flannel is not only warm in winter, but cool in summer. It should always be worn during the Indian cold weather and in the hills. During the hot season its desirability is doubtful.

The natural oil of the wool, which is well known now as a toilet preparation under the name of lanoline, is one of the most important constituents of flannel, but unfortunately bad washing frequent

ly removes this natural grease and leaves the materials practically worthless. Woollen-goods should, therefore, be washed in water which is only just warm, and soap, which should be of a good quality, should be used sparingly. A little kerosene oil added to the water will remove gross dirt.

Silk.—Silk, next to wool, is the best material for underwear, but its price places it beyond the means of all but the well-to-do.

Cotton.—Cotton has the great practical advantage of being hard, durable and cheap. It is introduced into most woollen materials to increase their durability and to prevent shrinking.

Specially woven and dressed, it is very largely used as *Flannelette.* This material is cotton in its worst form, and, on account of its inflammability, it is dangerous.

Linen.—Linen possesses no advantage over cotton as an article of clothing. It can be woven into finer materials and takes a higher finish, so that it must be judged from an æsthetic rather than a hygienic point of view.

Boots.—Boots should fit well at all times, and not cramp the foot or the toes.

In the Tropics, boots should be worn in preference to shoes in order to protect the ankles from the bites of mosquitoes.

Drawers.—It is as well to wear drawers in the Tropics. They promote cleanliness and protect the internal organs from chills.

Cholera Belts.—The flannel cholera belt generally fails to answer the purpose for which it is intended.

It is very difficult to keep in position and either rucks up under the ribs or lies in a roll above the hips. In either case it is of little value as a protection, and after exercise it becomes converted into a wet poultice over the abdomen.

We would restrict the use of the belt to night wear when it is most useful. If a blanket is relied on in hot weather, it is frequently tossed off by the restless sleeper with the result that the abdomen is chilled by the draught of the punkah and the comparative cool of the early morning.

The clothing of children.—An infant requires to be especially protected by clothing because it loses heat quickly by evaporation, its surface being in larger proportion to its bulk as is the case with everything small.

A child's clothing should be soft, light, warm and loose, and so arranged that it can easily be taken off. Every garment should be made to fasten with tapes and buttons, and an infant's binder should invariably be sewn on and not fastened with a safety-pin.

"Long clothes" are especially unsuited for the Tropics. Much money would be saved if children were put into short clothes at birth, and mothers should be brave enough to defy convention and refuse to swathe their infants in long sweeping garments during the first three months of life.

Children's bed-clothes should be light and warm, and, wherever possible, the insanitary coloured blankets which are so popular in the Tropics, should be replaced by white blankets which do "show the dirt."

Mackintoshes should be placed over children's mattresses, but they must never be put on over a baby's napkin, as the rubber causes irritation of the skin. Eiderdown quilts are undesirable for children's beds as they are not porous and cannot be washed.

Soiled napkins, even although they are merely wet with urine, must never be used a second time without washing, and good soap, free from excess of alkali, should always be used for this purpose.

Garters which interfere with the circulation and thus hinder the development of the limbs should never be used.

The stocking can be easily supported by a piece of tape sewn on the outer side and buttoned by a loop on to the bodice of stout jean which takes the place of stays.

Boots or shoes should not be worn until the child begins to crawl about, *i.e.*, at about the ninth or tenth month. To cramp its feet with boots or shoes before this time is both unnecessary and harmful.

The use of improperly made footgear spoils many a shapely foot. Boots should be made "square-toed," but not necessarily shapeless, and they should *fit*.

Children's boots should invariably be made to lace up and not to button. This method of fastening allows of making one part tight and another loose as circumstances require. They should only be laced as far as the last hole but one, and tied *loosely*. If laced right up to the top the bootlace often slips on the leg and chafes and restricts it.

Sandals are not suitable for tropical wear as they do not protect the feet from the bites of mosquitoes.

Babies' heads should not be wrapped up except in the most severe weather. With older children light loose fitting hats and caps should be used, and headgear of the type of Dutch bonnets avoided; sunshine and fresh air are essential to a vigorous growth of hair, and these cheap and invaluable hair tonics are not to be obtained if the head is strictly wrapped up. A light broad-brimmed mushroom-shaped *topee* is all that is necessary for wearing in the sun, whilst a similar covering in light straw is easily devised for use after sun-down. The *topee* must be worn out-of-doors even in the early morning : the sun is just as likely to produce sunstroke in the morning or evening as in the middle of the day.

Corsets should not be worn by children under fifteen years of age.

Girls should wear an easy fitting blouse, knickers and skirt suspended like a boy's trousers by straps over the shoulders; but *braces,* strictly so called, for *improving the figure,* should not be used.

The best way to develop a graceful figure is to indulge freely in field sports. This is now recognised by nearly all schoolmistresses, some of whom, however, are apt to go to extremes in this direction.

General remarks.—Cleanliness of the person cannot be maintained without due attention to cleanliness of clothing, and this applies not only

to garments which are worn during the day, but also those that are worn at night.

In order to ensure thorough cleanliness, persons should avoid sleeping in any garment worn during the day, and bedding and bed-clothes should be thoroughly aired every morning.

Supervision of laundry work is a point with reference to clothing which receives too little attention in the Tropics.

In places the washing is carried out in streams, which, owing to their receiving the drainage of the city, are horribly foul and in this way handkerchiefs and other articles of intimate use become contaminated with disease-germs in the so-called process of washing, and it is no far-fetched idea to accept the possibility of the spread of cholera, dysentery, enteric fever and other diseases by these means; the subject is in consequence fully worthy of earnest attention.

The ironing and storing of clothes after they have been washed is usually as badly carried out as the washing process itself. Too often the clothing is ironed in the bazaar and stored a night or two in the *dhobi's* living room before it reaches the owner's bungalow. This may account for many mysterious outbreaks of small-pox, measles and other diseases. It is a good plan when the clothes come from the *dhobi* to expose them to the sun for some hours.

(*b*) *For Indians.*

The general principles with regard to clothing in the Tropics for Europeans apply also to Indians.

In the great majority of cases cotton clothing is worn, with an additional woollen garment or two in the cold weather. This is satisfactory, provided certain necessary precautions are carried out. Of these the most important is always to wear clean clothes. Garments that have been soiled with perspiration or other discharges from the body are just as dirty as those soiled with dust or mud. Clothing wetted by perspiration or rain is a good conductor of heat, hence if a person sits about in wet clothes he loses heat rapidly and is very liable to get a chill. Indians are in the habit of wearing very little clothing at night, and hence at certain times of the year bowel complaints, pneumonia and other lung troubles become common. To avoid this it is necessary to keep the abdomen carefully covered, especially at night, and with the onset of the cold weather to have a blanket or other garment at hand which can be drawn over the body in the early morning when the temperature is liable to fall.

All clothes, then, should be changed at least twice a day, especially before going to sleep at night. Those taken off should be hung in the air and dried before being put on again. It is necessary to avoid wearing soiled clothes, or putting clean clothes on over dirty clothes—an unhealthy but not uncommon practice among a certain class of people.

Damp clothes should be changed at once, and precautions taken to keep the abdomen covered at night and to avoid a chill in the early morning.

If a man's work necessitates his being about in the sun a good deal and he is in a position to afford it, his clothing should be of a white or khaki colour externally and black or coloured internally. A suitable headgear and tinted glasses with side-pieces to protect the eyes are also desirable.

CHAPTER VII.

HOUSES IN THE TROPICS.

THE requirements of a healthy dwelling, where-ever situated, are six, *viz.* :—

1. A site which is dry and an aspect which gives light and cheerfulness.
2. A system of sewage removal so adapted to modern life that the sanitary precepts of their Religious Teachers and Sacred Books can be observed in their best sense by Hindus, Muhammadans and all concerned.
3. Proper means of ventilation.
4. A proper system of construction which will ensure perfect dryness of the foundation, walls and roof.
5. Proper means of warming the house in winter and cooling it in summer.
6. Efficient means of lighting.

1.—SITE.

The health of a locality is intimately connected with the nature of the soil on which the houses are built, and the best site is a gentle slope on a gravel soil. Clay soils should be avoided as they foster dampness, and if a house becomes damp, malaria, dysentery and diseases of the chest, are apt to occur. Sandy soils are undesirable unless covered with short grass. As turf is hardly ever seen in

India without irrigation and superabundant vegetation, the bare sandy soils which are common are very hot. If any choice is available, always build on the highest ground available, and invariably provide surface drainage so as to prevent pools forming which may become mosquito nurseries.

Marshy and swampy ground should on no account be used for building purposes and what are called "made soils" must be specially avoided. Such sites consist of hollows filled up with rubbish of all kinds and are obviously full of impurities which must, and do, produce emanations prejudicial to health.

2.—Sewage and Refuse Disposal.

This subject is fully dealt with in the next Chapter.

3.—Ventilation.

Ventilation has already been referred to in Chapter III, but we must emphasise the fact that an opening opposite the door or windows is an absolutely essential requirement in order to secure cross-ventilation.

4.—Construction.

When we realise that the houses of so many Indians are no more substantial than the sparrow's nest, it is obvious that the fourth requirement must be a dead letter to a large section of the community.

The following seven simple rules can, however, be carried out in the poorest dwelling :—

1. *Floors.*—The use of cowdung as a covering for floors is an unhealthy habit. Cowdung attracts flies and moisture and is a favourable breeding ground for microbes.

Mud floors should have the surface dug up and removed at least twice yearly.

Fresh mud should be laid down and beaten until quite smooth.

2. *Walls.*—These should be whitewashed four times yearly, inside and outside.

3. *Windows.*—Every room should have two windows at least 2 feet square opposite each other, or else one window 3 feet square opposite the door.

Windows should open to the outer air. They should be left open most of the day and all night.

4. *Cook room.*—A chimney or outlet for the smoke should be provided.

5. *Refuse and Waste Water.*—Refuse should be placed in a receptacle, and waste water emptied into a drain as far away from the house as possible.

6. *Latrines.*—These should be outside the general house building, should have a window and a solid floor and be easily accessible to the sweeper from behind.

7. Whilst a few plants and small trees in the neighbourhood of a house are pleasant, there should be no interference with the free passage of air and light to all parts of the dwelling, and all animals, fowls and pets should be separately housed outside the house and its enclosures.

Purdahs and hangings are to be avoided, as there is no proverb more true than the one that says: "where the sun does not enter the doctor does."

5.—The Cooling of Rooms.

Punkahs, thermantidotes, khus-khus tatties and electric fans form the means of reducing the temperature of our Indian houses. The custom, formerly popular in India, of avoiding the extreme heat of the summer by living underground is happily disappearing. Cellar rooms, although convenient, are dark, ill-ventilated and unhealthy.

A dark room may *seem* cooler, but is certainly far unhealthier than one into which air and even indirect sunlight are admitted.

6.—Lighting.

The agents employed in India are sunlight, candles, oil, gas, and electricity.

Sunlight is essential to health and no room should be without its cheering rays. It promotes human growth and prevents germ growth. No house is healthy unless sunlight has access to each room. It is one of the most potent and one of the cheapest agents for the destruction of the microbes of disease.

Candles.—These are made of tallow, wax, spermaceti, or stearin. Two sperm candles foul as much air as one man. They are comparatively feeble illuminants, but in themselves produce little or no ill-effects on the health.

Oil.—The chief illuminating oil used in the Tropics is kerosene. It consumes the oxygen of the air to a greater extent than candles. A good oil lamp of moderate size is equivalent to seven men in its power of rendering the air impure. Weight for weight, kerosene oil is twice as powerful an illuminant as candles. Cheap kerosene oils are liable to ignite and cause fires, and therefore their use for bath-rooms and similar purposes is a dangerous form of economy in India. The crude castor oil ordinarily used in Indian houses is as bad as cheap kerosene, but has the advantage of not being inflammable.

Coal Gas.—This is the most widely used illuminant in Europe but is comparatively little used in the Tropics. It possesses many disadvantages, being poisonous and explosive, whilst its use renders the air impure. It is, however, a cheap and fairly powerful lighting agent. Coal gas is a purified product of the distillation of coal and consists of a mixture of no fewer than eight or nine gases. One gas jet fouls as much air as five or six men, but the introduction of the incandescent burner renders the light more brilliant for a smaller consumption of gas and consequently diminishes the production of impurities, uses up less oxygen and produces less heat.

Acetylene Gas.—Acetylene is one of the constituents of coal gas. It is evolved when water comes into contact with carbide of calcium, a compound prepared from a mixture of lime and carbon. It is colourless, has a strong odour and can be stored in gasometers or burned in special lamps.

It easily explodes when mixed with air in a proportion of 7 per cent, but it is only very slightly poisonous. For household use improved apparatus for its combustion is required; ordinarily lamps have to be recharged with carbide frequently and the process is both difficult and offensive.

Petrol.—A large number of lamps are now in use in the Tropics which burn petrol. They give a brilliant white light of great intensity.

Electricity.—From a hygienic point of view, electric light is the best, especially for the Tropics as it has none of the disadvantages of the other forms of lighting. It does not vitiate the air, deprive it of oxygen, or yield to it carbonic acid, watery vapour, or much heat, while it is clean, and does not discolour walls or ceilings.

CHAPTER VIII.

The Disposal of Refuse in the Tropics.

Disposal of Excreta.

THE solid and liquid excreta of men and animals should be disposed of without undue delay. Latrines which are not kept clean or in which the discharges are allowed to soak into the ground are a serious danger to health. In many towns the sewage from private latrines is allowed to soak into and contaminate the ground outside the house or is collected in a pit where it decomposes and gives rise to a most pestilential odour. In such latrines flies breed, and it is these same flies which with their dirty feet settle on the food left exposed in bazaars and houses and contaminate it with the micro-organisms which give rise to dysentery, diarrhœa and other diseases. Hence the cleaning of latrines should be regularly and thoroughly done.

There are four methods of disposing of excreta in the Tropics, *viz.*, :—

1. The dry system of conservancy.
2. The wet system of conservancy.
3. Incineration.
4. The Biological Method (*i e.*, by means of "Septic Tanks").

1. *The Dry System of Conservancy.*—Latrines usually consist of corrugated iron sheds with partitions of the same material. They are fitted with glazed gumlahs, or tarred or enamelled iron

pans into which urine and fæces are passed, the contents being emptied into receptacles and removed daily, by means of iron carts, to a piece of ground outside the town or cantonment and there deposited in shallow trenches and covered with earth.

Latrines should always be placed on an impermeable base, made of concrete, and whatever variety of latrine is adopted, the following points must be borne in mind :—

1. The sun's rays must be brought to play upon the whole of the inside of the latrine for as many hours of the day as possible.
2. Free ventilation must be provided.
3. Rain must be kept out.
4. Privacy must be maintained.

The cardinal principle to be observed is that filth, refuse and all other putrescible matter, etc., must not be exposed to flies, or be allowed to contaminate the ground, but should be safely transported and disposed of.

In all latrines it is better to collect the night-soil and urine separately, because when they are mixed, decomposition sets in rapidly giving rise to fœtid gases, and splashing from the night-soil carts is liable to occur when excreta are being taken to the trenching ground. Urine may be mixed with water as it then decomposes less rapidly, but night-soil must be protected from rain and flood water and should therefore be collected in iron receptacles. In private latrines separate receptacles for urine and fæces are preferable, and the floor should be *pucca*.

Water-tight receptacles for night-soil and water-tight filth-carts must be provided and maintained on a system by which all danger and discomfort can be avoided.

A system of removal by day, instead of night, which latter cannot be watched effectively and leads to many abuses, especially in cold winter nights, is recommended, as an effective watch should be kept on the removal carts during the whole of their transit.

A sufficient area for trenching ground has to be provided to meet requirements, *i.e.*, (*a*) suitability of soil; (*b*) presence of irrigation; (*c*) suitability of distance from inhabited areas: and (*d*) a succession of quick growing crops.

Trenching grounds for night-soil should be high, well drained and at a distance from houses. If high ground is not available the ground should be drained and protected from flood water by ditches. The trenches should be two feet wide and one and a half feet deep with one foot between the trenches. Nine inches of night-soil is placed in them and the whole of the excavated earth is then put above it. Three months after trenching the ground should be ploughed and sown with crops such as sugarcane or tobacco. After the first crop vegetables of all kinds may be grown on it, and after twelve months the ground may be retrenched.

The defects in this system are three in number :—

1. The first is the fact that fæcal matter, in many dirty buckets, receptacles, etc., is left exposed for many hours at a time, open to the air, and accessible to flies.

2. The system often causes intolerable nuisance. The horrible smell caused by the passing of a night-soil cart is within the experience of all who have set foot in the East. The amount of nuisance caused increases in direct proportion to its bulk and to the amount of handling that is necessary.
3. The third and last defect is that it involves the use of dust-laden latrines. Bearing in mind what we have said in the First Chapter on the subject of enteric fever "carriers," it is obvious that the dry earth latrine affords for these individuals every facility for carrying out their baleful function of spreading the disease.

2. *The Wet System of Conservancy.*—The wet system of conservancy is directed towards the destruction of the microbes of disease, which are found in the liquid and solid excreta, and the inhibition of their action or their destruction is effected by disinfectants.

This system may be carried out with either a coal tar disinfectant, such as saponified cresol or a solution of perchloride of mercury.

No tanks or any special apparatus are required, but merely *gumlahs* and pans of native earthenware, chatties for storage of the disinfectant solution and syringes. The complete equipment of a large latrine, except the receptacles or *baltis*, costs about one rupee.

Anyone who doubts the benefits of the wet system has only to visit latrines in which it is

working and others where the dry earth, or litter fuel for incinerators are in use. In the former, flies will be few or absent: in the latter, they will be found in large numbers at all seasons of the year.

Whether carried out by the dry or wet methods, the hand removal system is not economical from a financial point of view. It necessitates a very large staff of sweepers, many carts, bullocks to pull the carts and a very heavy incidental expenditure. The wear and tear, of carts, buckets, etc., is enormous and the difficulty of getting repairs done to conservancy appliances is well known.

The appreciation of some of these difficulties led to the introduction of the next system.

3. *Incineration.*—As far back as the Crimean War, the British Troops burned their camp offal in improvised incinerators, built much in the fashion of lime kilns, but of recent years the disposal of refuse by burning has been advocated as a novelty and taken up with the greatest enthusiasm.

The following conditions for the proper incineration of night-soil are absolutely essential if the method is to be a success :—

(*a*) A properly designed incinerator.

(*b*) Constant intelligent supervision and efficient stoking.

(*c*) A liberal supply of fuel.

(*d*) A mixing platform provided with roof and a storage godown for the combustible material in wet weather.

If any of these four conditions are absent, sooner or later the process breaks down. It is necessary to say a few words about each of them.

(*a*) *Properly designed Incinerators.*—The great mistake of most types of incinerators is that the draught is not sufficient: the consequence is that there is a great deal of smoke which is often highly offensive. The presence of smoke is nearly always due to one of two things:—(1) Defective design of the incinerator: or (2) insufficient supply of dry and inflammable material.

Countless varieties of incinerators have been advocated from time to time and nearly every town has its own design and every sanitary enthusiast his own pet plan. The real essentials are: (*a*) an enclosed structure with grid on which material can be placed; (*b*) an air inlet preferably capable of regulation; and (*c*) a flue or air outlet preferably lofty to ensure a good draught.

(*b*) *Supervision.* — Constant supervision of sweepers is essential. If left to themselves, they almost invariably put the mixture of night-soil and fuel into the incinerator either too wet to burn or too much of it at a time, so that the fire smoulders, instead of blazes, with the result that a lot of smoke is generated.

(*c*) *Fuel.*—In order to burn night-soil a large quantity of combustible material is required, particularly if urine is to be disposed of as well. The best materials are wood shavings, sawdust, damaged bhoosa or pine needles.

The greater the amount of combustible material that is mixed with the night-soil the less the smoke and the possibility of nuisance. If any of these materials have to be purchased in open market the incineration of night-soil cannot be carried out

economically. Consequently an insufficient quantity is used : the night-soil is imperfectly incinerated, and the nuisance arising from the incinerator is often great.

The method in use with most incinerators in India was first introduced by the writer at Dagshai in the Simla Hills.

The Dagshai plan was to mix pine needles with both liquid and solid excreta and was, therefore, only applicable to certain hill stations, but the method has been made applicable to plain stations by adopting stable litter as the absorbent material. This involves the carting of litter into bungalow compounds.

The introduction of stable litter into compounds is obviously objectionable seeing that horse droppings are, as will be seen in the next chapter, a favourite breeding ground for flies and that these insects are now regarded as hardly less important than mosquitoes as disseminators of disease. The greatest care therefore should be exercised to prevent the smallest quantity remaining any length of time without being passed through the incinerator. Moreover it is necessary to see that the manure is destroyed and not merely roasted as is sometimes the case.

(*d*) *Fuel Sheds and Mixing Platforms.*—In a heavy downfall of tropical rain it is impossible to keep any material in a readily inflammable condition. Therefore, it is necessary that shelters should be provided for any mixing procedure adopted, and the storage of fuel.

Fuel sheds should be only large enough to contain two days' supply of fuel, surrounded with wire gauze which will admit of drying, and exclude flies, and, most important of all, provided with concrete floors.

The difficulties with reference to incineration may be considered under four headings: (1) Disposal of fluids; (2) Supervision of stoking, (3) Æsthetic; (4) The control of the sweeper.

1. *The Disposal of Fluids.*—The point with reference to incineration which appears to be debatable is the disposal of fluids.

We have calculated that 3 maunds of coal or 12 maunds of wood, would be required to evaporate the total amount of urine from a community of one thousand persons in one day. It would, therefore, appear that if complete destruction of fluids is really achieved in incineration, stable litter and refuse constitute a fuel of higher economic value than is generally supposed.

In practice, the evaporation of fluids is not always carried out. We have ascertained that in a cantonment where incineration has been adopted, fluid excreta were being tipped into a drain and flushed out from a specially constructed channel connected with the irrigation system.

2. *Stoking.*—The success or otherwise of incineration depends on effective stoking or the individual technique of the sweepers. Now these useful members of the Indian community are not naturally energetic, and themselves say that the disposal of urine is their greatest trouble; so being ingenious as well as slothful they endeavour

to get over their difficulty with the least possible inconvenience to themselves. Obviously it is easier to throw away liquids than to burn them, and, if not constantly looked after, they are likely to adopt this simple solution of a very difficult problem.

3. *Æsthetic.*—A serious æsthetic objection to incineration is the excessive smoke and smell associated with it. This is undoubtedly a nuisance, but it can be readily remedied by improving the combustion in the incinerator.

The appearance of incinerators is certainly less objectionable than that of the indescribably foul conservancy carts.

4. *Control.*—The gravest of all defects in this method is that whilst in other systems the sweeper does the right thing almost instinctively, in the practice of incineration he has to be carefully and constantly watched and controlled, as efficiency depends on his scrupulously burning all excreta, including liquids.

The Question of Cost.—There can be little doubt that the introduction of incineration has produced considerable *original* saving of funds, and that it was largely the claim of its advocates that it could be carried out for next to nothing, that commended it to many authorities.

We are inclined to think that the original savings were due to cheap and inefficient incinerators, cheap sheds and imperfect fuel, which have succeeded in bringing the system into considerable discredit. When carried out with proper apparatus

and fuel it is more than doubtful whether incineration will be at all cheaper than trenching.

The question we have to answer is, can we design any arrangement that is cheap; that requires a minimum of staff to work it; that rapidly puts all undesirable matter beyond reach of the omnipresent fly; and that does not cause a nuisance?

We believe that this question can now be answered in the affirmative, and that the next method to be referred to, wherever the necessary funds and water are available, is by far the best method of disposing of dejecta in the Tropics.

4. *Biological Treatment.*—This system of sewage disposal consists in the reception of sewage in what are known as *septic tanks*. It is a variety of the water-carriage system, and a liberal allowance of water is essential for its installation.

The sewage is flushed by water from a suitable latrine into a long thin closed tank varying in size with the number of individuals who are to use the latrine connected with it.

The most economic and satisfactory working depth for a septic tank in the Tropics is 6 feet but 5 feet does fairly well.

In most active septic tanks there is about 8 to 12 inches of light sledge, and the scum is frequently some 6 inches in thickness, so that it is obviously not desirable to decrease the depth below 5 feet.

A tank capacity of 12 to 15 gallons per user per diem, gives the best results. A grit chamber is provided for the collection of solid material and its removal if desired.

When the sewage enters the tank a leathery scum forms on the surface, from 2 to 6 inches thick; below this is the zone of fermentation, in which the sewage is clear but permeated by bubbles of gas that constantly keep rising and maintain a quiet movement throughout the whole body of the fluid; at the bottom is a layer of peaty material, very small in amount; small masses of organic matter are seen to fall from the top layer by their own weight, but on reaching the bottom, gas is evolved from their constituents by bacterial agency and the particles are floated up again; on reaching the top the gas bubbles burst, and the solid matter again sinks. This cycle is repeated, until practically the whole of the suspended solid material is liquefied through bacterial action.

The gas generated in tanks has been utilised for lighting and power purposes, but is not worth the labour of collection in tropical countries.

Septic tanks effluent must always be looked upon as potentially dangerous. Septic tank effluent, however good in quality, must on no account be passed into a river from which a proportion of the population of a town draw their drinking water.

The effluent or fluid which escapes from a septic tank is inodorous, and the most satisfactory method of disposing of it is to pass it over land. This method has been tried in Ootacamund where the nuisance, which was occasionally complained of when crude sewage was irrigated, has entirely disappeared.

Disposal of Garbage and Household Refuse.

The effective disposal of house waste, consisting of household refuse, paper, rags, and other more or less combustible material, constitutes one of the greatest difficulties which those responsible for the public health, in or out of the Tropics, have to face. The difficulty is increased by the fact that the material to be dealt with varies in quality and quantity according to the season, the kind of fuel used, and the habits of the people.

In the Tropics it is especially accentuated by the national habit of using the street as a depository for filth and refuse.

One has only to visit an Oriental city or village and wait a few minutes to see quantities of rice and other food material thrown into the streets, whilst the odour of the drainage channels is eloquent testimony that both liquid and solid ordure has been thrown into them from the houses.

We insist, therefore, that amongst populated centres in tropical latitudes, cleanliness and freedom from refuse matters of all kinds is the first essential to the public well-being.

By the expression "refuse" is understood what may be described as domestic household refuse, with, in most cases, some limited admixture of trade and shop refuse and in many districts a small proportion of vegetable and garden waste.

Refuse from houses, streets and stables, when kept for manure, should be collected on high ground at a distance from houses and roads. If it gets wet, fermentation and putrefaction occur.

The chief methods employed for the disposal of such materials from towns may be summarised as follows :—

1. *Depositing upon waste or low-lying land, and filling up of pits or excavations, or raising the level of marsh land.*—This method often gives rise to intolerable nuisance and cannot be recommended in the Tropics generally. Too often "made soils" are used for building sites with disastrous results.

If refuse is used for raising the level of low-lying land, it is necessary that the land be well away from the town or village and that it is not subject to flooding—flood water being kept away by bunds and drains. Tanks and depressions in which water collects should not be filled up with refuse, but with clean soil.

2. *Selling by tender yearly.*—As in India town refuse is found to be a good top-dressing for the production of grass, it will sometimes command a sale. This method commends itself to municipal authorities, as it enables them to get over a great difficulty without expense and even with profit; but it is not to be recommended, as the contractor is very often dilatory and unsatisfactory in carrying out the process of removal.

3. *Destruction by fire.*—This is by far the best method, but the methods of disposal in different districts have hitherto depended largely on local circumstances and conditions: the cheapest plan available having always the preference in the Tropics. Oftentimes this may be but a mere makeshift and the means of disposal for many years may be nothing better than a hunting about from one

makeshift to another, until at last, all other means having become exhausted, a refuse destructor becomes an absolute necessity.

Given a good destructor and proper management, town-waste and house-refuse can be reduced to about one-third of their original bulk, the residue being innocuous clinker, metallic refuse, and dust.

The adoption of incineration of excreta has the advantage of rendering the disposal of other refuse comparatively easy as destructors, of a kind, are always available; but unfortunately in actual practice, in one community at least, to our personal knowledge an attempt was made to burn urine whilst garbage was being carted a long distance and dumped on the fields.

Proper receptacles for refuse should be provided by all municipalities. They should be small, covered, and made of some kind of metal so as to be unabsorbent and they should be emptied at least once daily.

The magnitude of this problem of refuse disposal is apparent when we realise that for urban areas the quantity of ashbin refuse or garbage averages from four to five thousand maunds annually for each thousand inhabitants.

A proper system of scavenging is therefore the first essential to Sanitary Administration in the Tropics. Waterworks, drainage schemes, etc., are admirable in their way, but till the people of the Tropics have appreciated the necessity for domestic and street cleanliness, they must be to them as a learned book which they are often called

upon to master before they have acquired the alphabet of sanitation.

One of the chief defects in the sanitation of towns and villages is the absence of road drains to carry off water which has been used in washing and bathing and in cleaning utensils and clothes. Where possible this wash water should be led out by a *pucca* drain to a moveable receptacle standing at the ground level, on a concrete, stone or other impermeable base. Where this is impracticable the water may be led into a filter constructed by making a trench 18″ deep and 2 feet wide, loosening the earth at the bottom of the trench, putting in 6″ of rough stone or broken-metal, covering this with 6″ of clean gravel and then with 6″ of sand and on the top of all placing a single layer of stones to keep the sand in position. By this filter the waste water will be purified and soak into the ground without creating a nuisance; according to the size of the house the filter may be made wider and longer but not deeper. It must be carefully guarded against the inflow of rain water which would at once destroy its value. To do this the sides of the filter should be raised 6″ above the level of the surface of the ground.

CHAPTER IX.

Insects and Disease in the Tropics.

In number, in species, in all but one form of mentality, insects are the dominant form of life on the earth at the present time, but the limitations put on them are of such a nature that their dominance must remain within bounds and, unless man be removed, cannot be actual and entire.

Insects are of all sizes, from one-fiftieth of an inch or less in length, to over six inches and even more; their numbers are incalculable, the number of their species alone being put at about three millions. Their lives may be very short (a week) or as long as ten years and more, but they seldom live for more than three years and are seldom active for more than three months. On the surface of the earth, as in fresh water, they are found wherever nutriment is available, even in the bodies of warm-blooded animals and men.

The following is a list of injurious insects and the human diseases they are known, or supposed to transfer.

1. *Ants.*—These insects *may* readily convey all the diseases due to contamination of food, such as cholera, dysentery, and enteric fever, but there is no definite proof of this, though considering their habits in tropical countries it is far from unlikely.

2. *Bed-bugs.*—These loathsome insects are charged with the conveyance of anthrax, kala-azar, leprosy, some skin diseases, consumption, typhus fever and yaws.

3. *Fleas.*—It has been definitely proved that plague is conveyed by fleas.

4. *Non-biting Flies.*—The list of diseases laid to the door of the *House Fly* is a long one. It includes :—Anthrax, eye-diseases, cholera, diarrhœa, dysentery, enteric fever, maggots in wounds, leprosy, skin diseases, consumption and yaws.

5. *Biting Flies, apart from Mosquitoes.*—Midges and sandflies are said to convey anthrax and blood poisoning, whilst in Africa the tse-tse fly conveys sleeping sickness.

6. *Lice.*—Body lice have been charged with conveying tubercle and leprosy and they undoubtedly convey both typhus and relapsing fever.

7. *Mosquitoes.*—These insects are the sole agents for the spread of malaria and the yellow fever of Central America. "No mosquitoes, no malaria," is a universally accepted sanitary dogma of to-day.

8. *Sandflies.*—These insects have been shown to convey the three-day and five-day fevers which are common all over India.

9. *The Itch Insect.*—This is a member of the spider family which in addition to causing the disease known as *itch*, is charged with conveying leprosy and other skin diseases.

10. *Ticks.*—These pests are the agents for the conveyance of a large number of diseases of animals, and it has recently been shown that in Africa they convey the germ of a fever which closely resembles the *Relapsing Fever* of India—a disease now known to be conveyed by ordinary body lice.

Mosquitoes.

The first three stages of these insects are spent in the water, the last only on the wing. It follows, therefore, that water is essential to the existence of all mosquitoes.

The female mosquito haunts the vicinity of stagnant water with weeds growing in it and dead leaves floating about on it.

To deposit her eggs she alights on one of the floating fragments, forms her hind legs into a form of receptacle and drops her eggs on to it.

The eggs are surrounded by a gelatinous material: this binds them together into a little mass which falls on the surface of the water and floats about when the mother insect flies away.

In about three days the eggs open by a sort of little trap-door near their blunt end and out comes the tiny grub or larva, which is just big enough to be seen by the naked eye. From the first it swims about actively in the water.

It is very much preyed upon by small fish, and to avoid its natural enemies it has a great predilection for aquatic weeds, which provide it with grateful protection. It sheds its skin two or three times and grows rapidly. When fully grown it swims about in a fitful purposeless way and finally comes to rest. After a short stationary period the larva swells and a slit suddenly appears in the back. After a few wriggles a new creature emerges from the skin.

The *pupa*, as it is now called, has no mouth and of course cannot eat. It is, however, very

active, swimming rapidly by lashing the hinder part about. When disturbed it darts to the bottom of the pool, but soon rises again on account of its buoyancy, It no longer breathes through its tail, but has two trumpet-like bodies on each side of its chest. It is kept right side up and at the surface of the water by little airtight compartments and, as it floats back upwards, its head appears to be tucked underneath it. After two or three days the pupa case splits and the perfect insect emerges from it. It raises itself on its legs, withdraws its wings, and standing on the bouyant pupa case, lifts itself well into the air and flies away on its mission of annoyance and death. Sometimes the insect is unable to deliver itself: at other times a slight puff of wind upsets the raft on which it balances itself and the young mosquito is drowned.

A puddle is not essential for the development of the pupa as a moist piece of ground does equally well, but actual dryness is fatal to mosquitoes in all these stages.

The staple food of both sexes of mosquito is the juice of vegetables, but the female prefers blood.

Birds and all sorts of animals are bitten, and much experimental work on malaria has been done on the malarial fevers of various birds.

Mosquitoes can be kept alive in captivity for several weeks on bananas, but the desire for blood is so strong that they will even bite a corpse.

In cool climates the mosquito becomes lethargic, and either goes back to vegetarian habits or merely hibernates,

Mosquitoes in various stages of their development can live for many months and they can withstand long periods of cold.

Water is an absolute essential to the development of mosquitoes, especially stagnant water or the edges of picturesque marshy pools.

Generally speaking, they only turn out at sunset, but in darkened rooms they are common enough in the day : hence tropical rooms should be brightly lighted.

We are all too familiar with the humming and buzzing noise made by mosquitoes. This noise varies with the sex and species of the insect. It is produced by the vibration of the wings and by a special musical organ, the wings producing the deeper notes and the special organ the higher ones.

The Malarial Parasite.

The organism which causes malaria is a minute animal consisting of a single cell, but it has none the less well-marked characteristics distinguishing the sexes.

The time occupied in its development in the blood so as to produce fever varies from 36 hours to 15 days, according to the variety of the parasite.

Sandflies.

The sandfly is a keen rival to the mosquito in making things unpleasant for man in India.

As in the case of mosquitoes, the males are harmless, and it is the females who give all the trouble to mankind. Their small size gives them a great advantage over mosquitoes since they are able to

get through ordinary mosquito-netting without difficulty. The ankles are favourite points of attack and these flies will even crawl under the bed-clothes in their thirst for blood. They are found in bath-rooms especially near the floor and under bricks or stones, in the interstices of *chittai*, or in similar damp shady places during the day. At night they emerge from their seclusion to bite.

Infection by sandflies can be readily avoided by protecting the uncovered parts of the body and by using nets with a fine mesh. It is notorious that new-comers to a sandfly district in this country frequently get Sandfly Fever, whereas old residents who know how to protect themselves, and take the trouble to do so, enjoy complete immunity.

The following ointment is very useful when nets are not available :—

Oil of Aniseed	..	1 dram.
Oil of Eucalyptus	..	1 dram.
Spirits of Turpentine	..	$\frac{1}{2}$ dram.
Boracic Ointment	..	1 ounce.

House Flies.

There are several species which are commonly found in houses, although but one of these should be called the house fly proper. This is a medium-sized greyish fly with its mouth parts spread out at the tip for sucking up liquids. It breeds in a great variety of substances of a filthy nature, and is found in practically all parts of the world. On account of the conformation of its mouth parts the house fly cannot bite, yet no impression is stronger in the

minds of most people than that this insect does occasionally bite. This impression is due to the frequent occurrence in houses of another fly which is called the stable fly, which, while closely resembling the house fly (so closely in fact, as to deceive anyone but an expert), differs from it in the important particular that its mouth parts are formed for piercing the skin.

Several kinds of metallic green or bluish coloured flies are occasionally found in houses, the most abundant of which is the so-called blue bottle fly. This insect is also called the "blow fly" or "meat fly" and breeds in decaying *animal* material.

It feeds on the fæces of man to a great extent and is very partial to fruits of various kinds; hence it is very likely to be a carrier of disease.

In most parts of the world the house fly prefers to lay its eggs upon horse manure, this substance being its favourite larval food, but horse manure is not always available for it in the Tropics where in many parts every scrap of manure is made into cakes and used as fuel. In the Tropics the fly develops a taste for human excrement, and from this habit it becomes very dangerous to the health of human beings, carrying, as it does, the germs of intestinal diseases such as enteric fever and cholera from excreta to food-supplies. It will also lay its eggs on any decaying vegetable and animal material, but of the flies that infect tropical houses the vast majority come from either human excrement or horse manure. As the fæces dry and crumble, the maggots bury themselves in the earth, finding

a passage by way of cracks and the holes made by worms of dung-beetles.

Cowdung and the earth under it harbour fly maggots, but experiments have shown that house flies do not breed in ordinary ground as distinguished from organic deposits.

To attract the house fly ordinary household refuse must be in a state of fermentation, as flies breed in relatively small numbers in refuse where no fermentation has taken place. They do not breed at all in receptacles which are emptied at short intervals, but the use of disinfectants, as ordinarily carried out, does not prevent them breeding in such receptacles unless they are regularly emptied. Very dry or excessively wet ashes or moist cowdung will not harbour them.

The presence of fowls, but not ducks or geese, reduces the number of larvæ and pupa in stable litter to a very marked extent, and there are certain species of ants which destroy them with great rapidity.

The duration of the egg state of the house fly is twenty-four hours, the larval stage from three to five days, and the pupal stage from five to seven days.

The periods of development vary largely with the climate and season. The insect hibernates in the pupal stage in manure or at the surface of the ground under a manure heap. In the adult form it also hibernates in dark nooks and crannies in houses. The unceilinged roofs of tropical bungalows and native houses offer limitless facilities for the flies to enjoy undisturbed winter repose.

The number of eggs laid by an individual fly average about 120, and the enormous numbers in which the insect occurs is thus plainly accounted for, especially when we consider the universal presence of appropriate food.

Indeed, their fecundity, the rapidity with which one generation succeeds another and their great voracity, added to the extraordinary quickness of their production, are such that *Linnaeus tells us that three flies, with their generations which spring from them, could eat up a dead horse as quickly as a lion could.*

The general means of preventing flies are :—

1. Careful screening of all windows and doors during the summer months.
2. The use of sticky fly papers.
3. The prompt gathering of horse manure and its removal within 24 hours, or storage in special receptacles.
4. The use of disinfectants in latrines.
5. Absolute domestic cleanliness.
6. The use of trap breeding places, consisting of shallow trays containing horse manure. These are emptied every third day, their contents being burnt.

The prompt gathering of horse manure and its removal or destruction by fire or storage in specially prepared receptacles, and the proper use of latrines, would greatly abate the fly nuisance in this country, but even under existing circumstances absolute household cleanliness will always result in a diminution of the numbers of the house-fly.

The following rules for dealing with the Fly Nuisance might be published in the vernaculars, distributed to all residents in Indian towns and enforced by Indian Municipalities.

1. Keep flies away from the sick, especially persons ill with communicable diseases. Kill every fly that strays into the sick-room as this body is covered with disease germs.
2. Do not allow decaying material of any sort to accumulate on or near your premises.
3. All refuse which tends in any way to fermentation, such as bedding, straw, paper waste, and vegetable matter, should be promptly burnt.
4. Keep all food in doolies.
5. Keep all receptacles for garbage carefully covered, or sprinkle them daily with kerosene oil.
6. Remove all stable manure daily or dry and burn it.
7. Cover food after a meal, and burn or bury deeply all table refuse.
8. Cover with muslin all food exposed for sale.
9. Protect all windows and doors, especially in the kitchen and dining-room with wire gauze.
10. Don't forget that flies are bred in filth near where you find them. It may be behind the door or under the table, but it is probably a large or small heap of refuse near at hand.

If there is no dirt and filth, there will be no flies.

Bugs.

The bug is a most disagreeable insect and abounds in dirty houses, principally in towns and above all

in those of warm countries. It lives in beds, woodwork, behind pictures under *chittai* and carpets: indeed, there is no crack, however narrow it may be, into which it is unable to slip.

It is nocturnal in its habits as a rule, but is active at all times. Travellers are aware of the ingenuity of the insect in reaching its prey, and it has been observed that when all other means of access failed, it went to the ceiling, and fell on its victim from that position!

Fumigation with formaldehyde is the best agent for freeing buildings from this pest. Cleanliness, washing the floor and wooden bedsteads with kerosene oil emulsion, the use of pure pyrethrum powder, and fumigation with sulphur are the other means available against it.

LICE.

Three species of this insect affect man in the Tropics, *viz.*:—(1) The Head louse: (2) The Body louse: (3) The Crab louse: Other varieties occur in horses, goats, pigs, camels, dogs, etc.

It has been shown that the parasites of relapsing fever and typhus is conveyed by the louse, so that the prompt destruction of these insects is very important from a health point of view.

PREVENTION AND DESTRUCTION OF LICE.

The Body Louse:—The Louse has been well described as one of the minor horrors of the present war.

1. The individual himself is the main source of infection, that is to say, lice are mostly spread by persons infecting one another. One verminous person in a room is sufficient to infect others, who usually blame the room.

2. The main difficulty is lousy outer-clothing. Lice and their eggs, or nits, in addition to being present on the under-clothing, are present upon the outer-clothing. Often the outer garments are worse than the inner garments because they have not been deloused (*i.e.*, freed from lice by steam or boiling water.)

3. If clothing is not de-loused, the lice upon it almost immediately make for and re-infect clean clothing. No amount of bathing and clean clothing will prevent this.

4. Blankets, straw and beds are only minor sources of infection.

5. Most powders and ointments now sold for killing lice are of little value. Naphthalene and camphor are the best, but should not be used on the parts of clothing where the body is apt to perspire.

6. Whenever possible search clothing thoroughly and regularly for lice and eggs. Pay special attention to the seams, the collars of the coat and the forks of the trousers. Tear out the white patch at the fork, which only shelters the pest. Do not neglect the eggs. They are always hatching and so producing new parasites.

The Head Louse.—In women the hair need not be sacrificed. The lice can be killed by smearing the scalp with white precipitate ointment or rubbing

in kerosene and olive oil, equal parts. The hair must be combed with a fine comb dipped in vinegar to get the nits out. The vinegar dissolves the glutinous material which fixes the eggs or "nits" to the hair. Scrupulous cleanliness and care are sufficient to prevent recurrence.

The Crab Louse.—White precipitate or ordinary mercurial ointments are reliable remedies, and the parts should be thoroughly washed two or three times a day with soft soap and water.

The fork of the trousers or breeches used must be de-loused and freed from eggs by singeing with a match or tinder lighter.

Fleas.

Fleas were originally flies and had wings, but their form and structure has in the course of ages become profoundly altered in consequence of their parasitic habits.

Certain circumstances particularly favour the multiplication of the insect. It is most abundant in dirty houses, in deserted buildings, in ruins and in most places frequented by people of unclean habits. Several kinds of fleas live on animals, as, for example, the rat-flea, the dog-flea, and those of the pigeon and poultry.

The bite of the rat-flea constitutes one of the chief ways, even if not the only way, whereby plague is spread.

The rat-flea is essentially a parasite of the rat, but it does not confine its attacks to these animals, and it will bite man, especially (but not only)

when there are no rats on which it can feed. It is well known that before plague attacks human beings the rats of the place usually die of the disease. When the rats die, the fleas leave their bodies and then are particularly likely to bite men and thus infect them with the plague bacillus which the fleas have previously sucked up with the blood of the rats on which they last fed.

The chigger or sand-flea is not unlike the common flea, but is smaller in size. It is flat, brown in colour, with a white spot on the back, and is armed with a strong pointed beak provided with lancets. It is with this instrument that the female attacks man.

Like the flea, it usually haunts dry sandy soil, the dust and ashes in badly kept native huts, the stables of cattle, poultry pens, and the like. It greedily attacks all warm blooded animals, including birds and man.

The chigger attacks chiefly the feet. It slips in between the flesh and the nails, or gets under the skin of the heel. The process does not cause any pain at first, but after a few days, irritation appears, which, although at first slight, gradually increases and ends by becoming unbearable.

The chigger when under the skin becomes as large as a small pea, and surrounds itself with a large brown bag containing matter. In this bag are collected eggs which issue from an orifice in the posterior extremity, but are not hatched in the wound itself.

As a cause of suffering, invaliding and indirectly death, it is an insect of some importance. It is

now extremely prevalent on the East Coast of Africa, and is causing a large amount of invaliding amongst the Indian coolies there, by whom it has been introduced into India.

ANTS.

In general, ants are scavengers, the workers bringing to the nest the food for the whole community. This food consists of dead insects and other animal matter, the sap of plants and any edible vegetable matter that can be obtained. In this sense ants are excellent scavengers, and as they are practically everywhere in the open they serve an extremely useful function in the Tropics.

In some species the habit is specialised in one direction, some are "harvesters," storing in their nests seeds of grasses, small millets and rice.

Hitherto no conclusive evidence has been produced against the ant as a disseminator of disease, on the contrary, a certain species is said to render valuable service by destroying the eggs and larvæ of house flies.

THE SCORPION FAMILY.

Ticks—These little animals constitute a large proportion of this section of the animal kingdom, and recent developments in tropical medicine have shown that they play an important part in the transmission of disease. They are widely distributed, almost every animal either having specie

to itself or being liable to attack by the parasites of other animals.

They are always visible to the naked eye, and the females are almost invariably larger than the males. In some species the former, when gorged with food, may reach a length of nearly half an inch. As a rule they are temporary parasites, but some live in a quasi-permanent manner on the body of their host: and occasionally a few, such as the sheep tick, may burrow beneath the skin.

In habit the tick resembles the common bed-bug. It lives in huts, hiding during the day in cracks in the walls and floors, or in thatched roofs, and moving about actively during the night in search of nourishment. It feeds slowly and is unable to get much blood from any but a sleeping person.

Ulcers and a severe form of fever which is common in Southern India are attributed to a tick very common there.

An African tick has proved to be the disseminator of the "Coast" or "Tick Fever," which closely resembles the "Relapsing" or "Famine Fever" of India.

CHAPTER X.

Disinfection and Disinfectants in the Tropics.

The object of disinfection is to destroy the germs of disease, but unfortunately three groups of agents are usually confused together under this single heading, *viz.* :—

1. *Antiseptics, i.e.*, substances which arrest the action of bacteria but do not destroy them, such as boracic acid.

2. *Deodorants, i.e.*, substances which counteract disagreeable odours such as charcoal, toilet vinegar, and many *so-called* disinfectants.

3. *Disinfectants proper, i.e.*, substances which really destroy germs, such as carbolic acid.

1. *Antiseptics.*—An antiseptic is an agent which prevents decomposition. The application of this group is limited to substances and places where removal or destruction are undesirable. Its members require the most careful and discriminate employment to be of value in preventing the evil results of infection by organisms.

Preservatives are closely allied to antiseptics in their effect upon organic substances, and the preservation of food by physical means, such as (1) cold, (2) exclusion of filtration of air, (3) chemical means, such as smoking, salting, and (4) the use of various chemical substances, are really antiseptic processes not far removed from the methods of modern surgery.

The word "antiseptic" means prevention of sepsis or decomposition.

Antiseptics merely act by preventing the growth and development of the micro-organisms which induce sepsis. They do not destroy them.

2. *Deodorants.*—Decomposition and putrefaction are the result of micro-organic life in the resolution of organic substances into their innocuous elements. During this transmutation malodorous gases are given off, and *deodorants* act by overpowering, absorbing or neutralising those gases, but they have no effect upon the decomposing substances.

Odours are the tell-tale of filth, and simply masking them is a most fallacious remedy and should never be adopted, least of all in the Tropics.

3. *Disinfectants proper.*—Disinfection in the more restricted and accurate sense, implies the destruction of the infection produced by the specific micro-organisms of disease.

Happily, in addition to the practice of strict cleanliness which removes and destroys microbes, we have a large group of *true* disinfectants that may be classed under the following headings :—

1. Natural Disinfectants.
2. Physical Disinfectants.
3. Chemical Disinfectants.

1. *Natural Disinfectants.*—Fresh air and sunlight will kill most germs, whilst all living micro-organisms are sooner or later attenuated in their disease-producing activities and finally killed by drying.

Thus the Spirillum of Asiatic Cholera, when dried, dies in from three hours to two days, according to the degree of desiccation.

The bacilli of typhoid fever are destroyed in from one and a half to two hours by the direct solar rays, and in five hours by diffuse daylight. The Diphtheria Bacillus is destroyed by from one-half to one hour's exposure to direct sunlight: while Koch found that the Tubercle Bacillus is killed by the rays of the sun in from a few minutes to several hours, according to the thickness of the mass exposed.

The influence of drying on the multiplication of bacteria, for none of them develop in the dry state, is of manifest importance, as it is known that the maintenance of the habitation and surroundings of the Indian in as dry a state as possible is a stringent sanitary necessity. The frequent airing of bedding and clothing secures the desired dryness: and in addition the oxygen of the air exercises a destructive effect on such organisms as may be harboured in these articles, whilst the agitation to which they are subjected in a very strong breeze not only mechanically dislodges and removes a considerable proportion of the adherent microbes, but also markedly interferes with the development of certain species.

Nature's disinfectants are, therefore, fresh air, wind and sunshine.

2. *Physical Disinfectants.*—The physical disinfectants consist of heat in its various forms, *viz.* :—

(*a*) Fire.

(*b*) Hot air.

(*c*) Boiling.
(*d*) Steam.

(*a*) *Fire.*—Destruction by fire is the most thorough means of disinfection, and it should always be employed for articles of little value. Where possible the material should be soaked in kerosene to ensure complete and ready combustion.

Bazaar dwellings, which are cheap and readily constructed, are best disinfected by fire, especially in such diseases as plague, but whenever such action is taken for portable articles, the employment of a closed incinerator is desirable as if destruction by fire is carried out in the open air small unburnt particles carrying infectious material may be scattered by the action of the wind.

It was undoubtedly the purifying influence of the Great Fire which freed London from plague in 1665.

(*b*) *Hot air.*—This method of disinfection is now discredited, as it has been found to be unreliable.

Its *advantages* are :—(1) It is economical, (2) an ordinary *oven* can be used for the purpose in emergencies, and (3) within certain limits it does not destroy articles, such as furs, leather, India rubber and bound books.

Its *disadvantages* are :—(1) that it has slow and feeble penetrating powers, (2) it is likely to stain certain articles, and (3) it renders some articles brittle and damages others.

(*c*) *Boiling.*—One of the best methods of disinfection is boiling. There are few organisms which will stand boiling for a few minutes and still fewer

which will stand a subsequent washing in soap and water.

The *disadvantage* of boiling is that it is apt to fix albuminous stains, and if it be employed, *e.g.*, for clothes, these must first be soaked in cold water, washed with soap and soda and then boiled for half an hour. The water in which they have been soaked and washed must also be disinfected by boiling.

(*d*) *Steam.*—Applied in special forms of apparatus, steam is now largely used in the Tropics for disinfection of bedding and clothing. Its superiority over air is due to the following reasons:—

(1) *The large amount of latent heat in steam.*—When steam condenses it parts with an immense amount of heat which is all available for disinfection.

(2) *Its penetrative power.*

(3) A lower temperature continued for a shorter time suffices for adequate disinfection.

(4) There is less risk of fire and of injury to most fabrics.

3. *Chemical disinfectants.*—The number of chemical disinfectants on the market is enormous. They may be divided into:—

(*a*) Gaseous.
(*b*) Liquid.
(*c*) Solid.

(*a*) *Gaseous.*—The principal gaseous disinfectants are burning sulphur, formaldehyde and chlorine.

Burning Sulphur.—The gas produced by burning sulphur has been in use for centuries as the most convenient form of gaseous disinfectant. It is essential that all surfaces with which the gas is to

come into contact should be thoroughly damped as the gas only acts in the presence of moisture.

Rolled sulphur or the specially prepared candles should be used, as the powdered sulphur is frequently impure. Two pounds of sulphur are required for each 1,000 cubic feet of space.

Formaldehyde.—This gas is liberated from tablets by heating in some special form of lamp. It has largely replaced sulphur of recent years.

It may be readily generated by pouring formalin on permanganate of potash.

One pint of formalin poured on ten ounces of permanganate in an ordinary galvanised iron pail is sufficient to efficiently disinfect 2,000 cubic feet. The period of disinfection should be six hours. From 60 to 70 degrees F. is a proper temperature, and the air of a room must be rendered moist in a dry country.

The method is very effective, simple, rapid, and by virtue of the inexpensive apparatus required, preferable to the older and more cumbersome methods.

Chlorine.—This element is useful as a disinfectant but is a powerful bleaching agent and should only be used where the other two gases mentioned are not available. Half a pound of hydrochloric acid or any other mineral acid will liberate the gas from 2 lbs. of chlorinated lime.

It should be borne in mind that the air of an infected room can readily change, and, therefore, does not require disinfection. Moreover microorganisms have weight and do not remain in the

air, but sink on the floors, walls, furniture, so that our attention should be devoted to them.

(*b*) *Liquid Disinfectants.*—There are six substances, or groups of substances, in common use in the Tropics as liquid disinfectants, *viz.* :—

(1) *Perchloride of Mercury or Corrosive Sublimate in solution of various strengths.*—It has the advantage of being the most powerful disinfectant and cheap. Its disadvantages are that it is very poisonous to man but slightly so to insects ; it corrodes metal, and its solution has neither colour nor smell.

(2) *Cyanide of Mercury.*—This substance is quite as powerful a disinfectant as corrosive sublimate. It has the advantage of not being rendered inert by coming into contact with animal matter, and is therefore well adapted for use with mud floors smeared with cowdung. Unfortunately it is five times as expensive as perchloride of mercury and goes no further.

(3) *Carbolic Acid.*—This is a good disinfectant, but expensive and poisonous. It has now been largely replaced by the cheaper and less poisonous products of coal tar.

(4) *Saponified Cresol.*—This is the preparation officially adopted by the Military Department out of a great mass of tar oils now on the market. It is cheaper and more efficient than carbolic acid and not nearly so poisonous.

(5) *Formalin.*—This has an irritant odour, but is harmless to colours and metal work with the exception of iron. It is a fairly cheap, rapid and reliable disinfectant, in one per cent. solution.

(b) *Phenyle.*—This popular disinfectant is a feeble disinfectant, as it is little more powerful than carbolic acid.

(c) *Solid Disinfectants.*—We shall only refer to five substances under this heading, *viz.* :—

1. Lime.
2. Chloride of lime.
3. Permanganate of potash.
4. Ferrous sulphate.
5. Soap.

1. *Lime.*—Freshly burned lime is a cheap and useful germicide. In the form of whitewash it is a disinfectant which plays a useful part in the Tropics. It is important to see that lime used for disinfecting purposes is fresh, as if stored for any length of time the action of the air converts a large amount of it into chalk which has no germicidal properties.

Some authorities have found that ordinary whitewashing destroys all micro-organisms except those of anthrax (or splenic fever) and tuberculosis.

Prior to the application of whitewash, the surface should be well scraped as we should aim at the removal of bacterial life, rather than its burial, even under a germicide.

2. *Chloride of Lime.*—Bleaching powder is a powerful but disagreeable deodorant, and a disinfectant of considerable power. It consists of lime saturated with chlorine and is of very unstable composition. It corrodes metals and blocks drains.

It used to be largely *misused* to hide offensive odours. Its chief legitimate use in the Tropics is to purify water as laid down on Page 51. It is

also used to keep off flies, but for this purpose crude petroleum is better.

3. *Permanganate of Potash.*—When used in five per cent. solution it is a powerful disinfectant, but as generally used, in less than a half per cent. solution it merely acts as a weak deodorant. It has the following disadvantages :—(1) It is expensive, (2) it stains fabrics, and (3) it is too easily reduced to an inert form. It is used with advantage in the disinfection of wells.

4. *Ferrous Sulphate.* — Green Copperas acts mainly by its reducing action, a process in which it absorbs oxygen. It is a feeble disinfectant unless used in great strength (20 to 30 per cent.), but it is a good deodorant, absorbing ammonia and sulphurretted hydrogen.

In practice it is suitable only for excreta, as it stains badly and tends to form iron moulds.

5. *Soap.*—Common soap is one of the most generally useful of the chemical disinfectants. The alkali in ordinary household soap not only actually destroys germs, but also tends to dissolve the outer covering of their seeds. It also washes away the greasy materials which frequently protect bacteria from the action of the natural disinfectants sunlight and oxygen, and is, therefore, a very valuable purifier.

When a case of infectious disease occurs, the following rules should be observed :—

1. Whenever a steam disinfector is available all articles of bedding, carpets, hangings, etc., which are not likely to be injured

by steam should be sent to the disinfecting station.

2. When a steam disinfector is not available cotton and linen articles should be boiled for half an hour. Blankets and other wool articles and coir fibre should be soaked for two hours in saponified cresol. Cloth articles should be sprayed with a five per cent. solution of pure carbolic acid in water and exposed to the sun for three or four days. Leather articles should be sponged with a one per cent. solution of formalin.
3. Feeding and cooking utensils should be boiled for 15 minutes. Immersion in a 20 per cent. hot solution of washing soda suffices for infectious diseases ; but it will not serve in cases of infection by the *Tubercle Bacillus*. Table knives, mounted forks and similar articles should be soaked for two hours in a one per cent. solution of formalin.
4. The walls of the room occupied by the patient should be scraped and re-lime-washed.
5. Furniture, floors, and wood work should be scrubbed with hot water and soap.
6. Earthen floors should be saturated with a disinfectant preparation, preferably kerosene emulsion with two per cent. of Cyanide of Mercury.
7. The wood work of latrines used by the patient should be scrubbed with a

Mercuric Chloride solution of ·05 per cent. and the floor saturated with the same solution.

It is often a wise precaution to disinfect any adjacent well by quicklime or permanganate of potassium. The permanganate should be dissolved in a bucket of water and the solution poured into the well. Undissolved crystals should not be thrown in. In adding the solution of permanganate of potassium or emulsion of lime, care should be taken to reach each part of the well. The formula for calculating the amount of lime necessary to disinfect a well is :—(Diameter of well in feet) $2 \times$ (depth of water in well in feet) = number of pounds of lime required. The answer to the same formula divided by ten will give approximately the number of ounces of permanganate of potassium required.

The Destruction of Insects.

Good disinfectants are not necessarily good insecticides, as, for example, Mercuric Chloride, which, although it is one of the most powerful of all disinfectants, has little influence on insect life.

Fleas will emerge unscathed from an exposure of ten minutes in an acid solution of Corrosive Sublimate of such a powerful strength as 1 in 500. Moreover, the disinfecting action of this chemical is considerably neutralised by organic matter on floors and walls, and especially in the case of mud floors of huts and houses which are smeared with cowdung.

The *best insecticides* are :—

1. Peterine.
2. Kerosene Oil Emulsion.
3. Kerosene Oil and Cyanide of Mercury Solution.
4. Saponified Cresol.
5. Sulphur Dioxide Gas.
6. Formaldehyde.

The last three mentioned have already been dealt with. The first three, however, require brief special mention.

For general purposes the gaseous disinfectants should be used chiefly as insecticides. For efficient use as disinfectants the room to which they are applied should be carefully sealed up, and this is a very difficult procedure with the ordinary tropical room.

In a strength far short of that in which they will destroy bacteria they will, however, act as efficient poisons to mosquitoes and other biting flies which survive in nooks and crannies from one year to another.

1. *Pesterine.*—This substance is crude petroleum (fuel oil) and is undoubtedly a powerful insecticide, as it instantly kills all fleas, bugs, and other insects that come in contact with it. Its method of application is very simple, as it has only to be brushed on the floors and the walls of rooms to a height of about 3 feet. It is very cheap, as the cost of treating an average-sized room is only about one rupee. It is not, however, an elegant preparation, hence its use in better class houses is open to some objections.

2. *Kerosene Oil Emulsion.*—This emulsion is made according to the following formula :—Common soap, 3 parts : water, 15 parts : and kerosene oil, 82 parts.

The soap is dissolved in the water by aid of heat, and the kerosene oil is warmed and gradually stirred into the mixture.

It has been shown that one part in a thousand of this solution will kill fleas in two minutes.

It should ordinarily be used diluted with twenty parts of water.

3. *Kerosene Oil and Cyanide of Mercury.*—This compound consists of two parts of cyanide of mercury added to each hundred parts of kerosene oil emulsion.

Where cost is not the chief consideration, as is too often the case in the Tropics, this compound is an ideal preparation for disinfecting Indian houses as it is not only an efficient insecticide but a powerful disinfectant.

All things considered, pesterine or kerosene oil emulsion fulfil all requirements.

All persons should have some knowledge of the why and wherefore of disinfection so that they may be able to appreciate the importance and difficulties of the procedure.

Large sums of money are annually wasted in this country because municipal authorities, and too often their advisers as well, have failed to understand that the haphazard scattering of expensive chemicals is *not* disinfection but merely a survival of old-world fetishism, whereas *true* disinfection is a scientific process with a well established dogma and elaborate ritual.

CHAPTER XI.

Hygiene of the Mouth.

It is very desirable to keep the mouth clean, and to prevent the accumulation of food between the teeth, where it decomposes leading to disease of the teeth, the gums, and the membrane of the mouth.

1. Disease of the teeth begins on the surface and makes its way to the soft central part of the tooth. From there it tends to pass to the root of the tooth where an abscess may form. This is associated with great pain, and the matter which forms spreads in the gums under the teeth, and may burst out on the gums, or on the cheek or in the neck. The teeth are loosened and may fall out and the jaw-bone may become diseased.

2. Inflammation of the gums may also be due to neglect in keeping the mouth properly cleaned. The gums become swollen and soft, sores form on them, they bleed readily, and the breath smells badly in place of being sweet like that of a cow. The teeth become loose and fall out. The gums are tender and mastication of food is attended with pain. In people of middle and old age a chronic form of inflammation of the gums is very common in India. It is due to a dirty condition of the teeth often associated with the eating of pan, betelnut and lime. Pieces become lodged in the spaces between the teeth and are allowed to remain there; decomposition follows and a

brownish crust of mineral matter, called tartar, is deposited on the teeth and can only be removed by scraping. Ignorant people may think that this tartar which looks and feels like stone is a good thing. In reality it is due to the dirty habit of not keeping the mouth clean, and leads to serious disease of the gums. Matter is formed and escapes between the gums and teeth. The gums gradually waste away, the roots of the teeth are exposed, they become loose, cannot be used and finally fall out. The discharge from the gums also is swallowed with food and saliva and leads to indigestion and ill-health. Without good teeth there cannot be mastication ; without mastication digestion is impaired ; without digestion food cannot be assimilated ; the result is that nutrition is impaired and the health suffers.

3. Another trouble which follows want of cleanliness of the mouth is inflammation of the membrane of the mouth with formation of sores on the gums, lips and tongue. This is attended with an excessive flow of saliva and tenderness of the mouth, while eating is often very painful.

4. To avoid all these troubles it is necessary to cleanse the mouth with water carefully, especially at night before going to sleep. The teeth should be rubbed and care taken to remove any particles of food, etc., which may be lodged between them. This can be done best by means of a silk thread passed between them. When teeth are so decayed or so loose that they cannot be used, they should be removed. If tartar forms on the teeth it should be scraped off, and when the gums are diseased a

doctor should be consulted and the treatment of the gums persevered with till they are quite well again. Where skilled medical advice cannot be obtained, wash the mouth out with water after every meal and rub the gums with the fingers towards the teeth so as to press out any matter which may have collected between the gums and the teeth. As far as possible avoid swallowing this matter. Careful and regular cleansing of the mouth will prevent much pain and ill-health.

CHAPTER XII.

THE HYGIENE OF CAMPS IN THE TROPICS.

"*For the Lord thy God walketh in the midst of thy camp......therefore shall thy camp be holy; that He see no unclean thing in thee and turn away from thee.*—(*Book of Deuteronomy, Chapter XXIII, v.* 14.)

NEARLY four thousand years ago there was a great general and his name was Moses. He passed many years of his life in the supreme command of great camps in a tropical country and it must have soon become apparent to him that unless strict sanitary legislation was enforced the troops under his command, and their followers, would have been decimated by the various diseases which, as we have seen, dog the footsteps of every great host on the line of march.

Moses was learned in all the wisdom of the Egyptians, and he set about the question in the only way which would appeal to an ignorant and superstitious people.

He accordingly published the general order which has been selected as—so to speak—the text of this chapter, declaring that the God of Israel was fond of walking in the camp of His children and that, therefore, it must be kept in a sanitary condition.

His device was successful, for we know that his great following passed through its long years of a nomadic existence singularly free from epidemic disease. We cannot copy him by making our

sanitary rules of the ritual of a great faith, nor can we make our followers believe, like the Japanese, that the spirits of their ancestors hover round the bivouac fires, but we can adopt the first principle of Moses and start our camp with clear orders on sanitary subjects and a definite sanitary *bandobust.*

The following points require consideration with reference to camps :—

1. Sites.
2. Tents.
3. Water-supply.
4. Cooking arrangements.
5. Latrines and urinals.
6. Disposal of refuse.

The site for a camp or bivouac should, if possible, be in a gentle slope to facilitate drainage.

The vicinity of large woods with undergrowth, marshes, paddy fields, or recently ploughed land ought to be avoided, as mosquitoes and biting flies are likely to be plentiful in such localities.

Should it, however, become necessary to encamp near ground likely to be infested by mosquitoes, the camp should be pitched to the windward of a belt of trees or a screen of some kind with a view to intercepting the wily mosquito in her flight.

Ravines and water courses are dangerous sites, as a sudden fall of rain may convert them into large streams.

Previously occupied ground should always be avoided, as the soil must have been contaminated and polluted to a greater or less extent, and there is always a possibility that " carriers " of disease may

have been present, infecting the vicinity with the microbes of enteric or some other disease.

Old camping grounds can be readily recognised by the raised mounds marking the site of the latrines.

An ideal site would be a gentle slope free from any great irregularities of surface, situated near the summit of rising ground on a sandy or gravel soil and adjacent to a mountain stream which has no huts or villages on its banks.

Camping grounds conforming to most of the essential requirements are to be found in most parts of India.

When possible, a camp should always be arranged as if for permanent occupation. In regular standing camps it is especially desirable to provide sufficient space for the moving of tents so as to cleanse and purify the ground underneath each tent at frequent intervals. All tent flies are to be looped up the first thing every morning and the tents should be struck periodically, and the ground underneath well swept and left exposed to the sun and air for some hours. The interval between the striking of tents should not exceed 3 or 4 days, and it is desirable that a second site should be available to which the tents can be moved if desired. Tent doors should always face the prevailing wind.

Trenches should always be made round tents to receive rainwater, and channels cut to carry off this water and provide surface drainage.

In malarial districts mosquito nets must be used.

The entire contents of the tent should be spread out in the sun daily. This is a sanitary precaution which should never be omitted.

Water-supply.—A good water-supply is essential for a camp in any climate, but in the Tropics it must never be situated at a considerable distance from it, as the native water-carrier thinks one water as good as another and will bring in a polluted supply most light-heartedly if it saves him the least trouble to do so.

All water receptacles should be thoroughly cleaned out daily with a solution of permanganate of potash made by adding one tea-spoonful of the crystals to three gallons of water, If after rinsing, the solution comes out discoloured it shows that cleansing was necessary. Repeat the process till the water retains its pink colour unaltered.

All vessels for storing water in camp must be kept carefully covered and provided with taps. Drinking direct from taps or direct from storing vessels of any kind should be dealt with very severely.

Where possible, separate intakes for water-supply should be provided for European and camp followers.

Drinking places for animals, and wash places, should always be allocated lower down stream than these intakes. Horses and animals should be watered from troughs, where possible, to avoid unnecessary fouling of streams.

The principles affecting water-supplies generally which have been laid down in Chapter IV apply, of course, where practicable to camp supplies.

A simple method of sterilizing any water which it might be dangerous to drink is as follows:—

(*a*) Take a tea-spoonful of bleaching powder (chloride of lime) and make it into a fine paste by the addition of a small quantity of water.

(*b*) Add the paste to half a pint of water and mix well.

(*c*) Add one tea-spoonful of this mixture (well shaken up beforehand) to each two gallons of water to be purified. Do not drink the water until it has stood for half an hour. The mixture must be made fresh daily.

(*d*) Bleaching powder deteriorates rapidly when kept in cardboard boxes or exposed to the air. The strength of the powder may be roughly estimated by the smell of chlorine which is familiar to all. If it is thought that the powder is weak, two tea-spoonfuls should be used instead of one.

Cooking Arrangements.—Camp kitchens should be situated (*a*) as far away as possible from the latrines, urinals and refuse receptacles, (*b*) to the windward of the camp, and (*c*) as near as possible to the water-supply.

Kitchen waste water contains a large amount of grease, and unless specially treated this substance forms a foul scum in water drains which rapidly becomes offensive and always attracts flies.

The following methods of disposal have been found to be good and easily improvised :—

1. Two kerosene tins of different sizes, or a tin and a basket, are taken. The inner and smaller tin or the basket acts as a coarse strainer. When a tin is used it has its bottom perforated all over with a nail. When full it is emptied into a refuse tub. The outer and larger tin directs the water over a small pit which acts as a grease trap, and is filled with

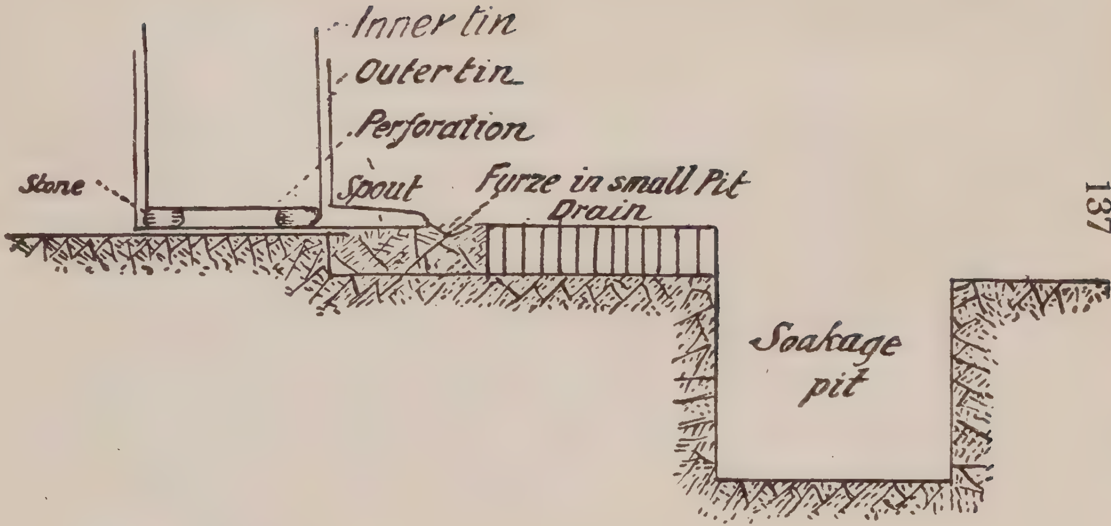


FIG. 1.—METHOD OF DISPOSING OF SULLAGE WATER IN CAMP.

dried grass, hay, or brushwood, which is burnt and renewed daily. A narrow and shallow trench runs from the small pit into a large soakage pit. If *large* stones are available, the soakage pit should be filled up with them. The spout of the lower tin is easily made by making an inverted V-shaped incision in its side, turning it down and rounding off.

2. This is simply an adaptation of 1. When two tins or a tin and a basket are not available a box is turned upside down over the small pit, a hole is cut out in its bottom, and a piece of perforated tin fitted into the hole.
3. A grating placed over the soakage pit on which furze or other straining material is placed. It is not so efficient or cleanly as 1 and 2.

In all the varieties the brushwood or grass used to entangle the grease should be soaked in crude petroleum to keep off flies. It should be replaced by fresh material and burnt daily.

All food should be kept in covered receptacles and some form of swill tub devised. Refuse should be sprinkled with petroleum to keep off flies and transported to the camp crematory as soon as possible. All water for washing up should be boiled and only well baked sand, wood ashes or bath brick used for cleaning utensils. The use of *mutti* should be prohibited as it may swarm with microbes.

Latrines and Urinals.—These should be placed to the leeward of the camp and one hundred yards from the nearest tent. They must never be dug in nullahs whence the excreta may be washed into a water-supply by heavy tropical rains.

Each trench should be 3 ft. long, 1 ft. wide, and 1 ft. deep, the interspace between each trench being 2½ ft.; men should use these trenches straddlewise, and at once cover up their deposit with earth. Five trenches will suffice for 100 men for one day; they should then be filled in with earth and the turf replaced.

Trenches required for the second day of occupation will be dug in the spaces between the first row of trenches.

The method of preparing the short trench latrine is shown in Fig. 2.

'If the area of the ground be limited, trenches 12 ft. long, 12 inches wide and 3½ ft. deep should be dug.

The men should straddle the trench and be instructed to cover their excreta with earth.

Empty kerosene oil tins are excellent substutites for trenches and should always be adopted instead of them in a standing camp in the Tropics as they permit of the wet system of conservancy.

Kerosene tins may be utilized as receptacles. Two or three inches of a disinfectant solution are placed in the receptacles and the contents disposed of by burial.

This plan obviates the plague of flies which is almost unavoidable when trenches are used in hot weather.

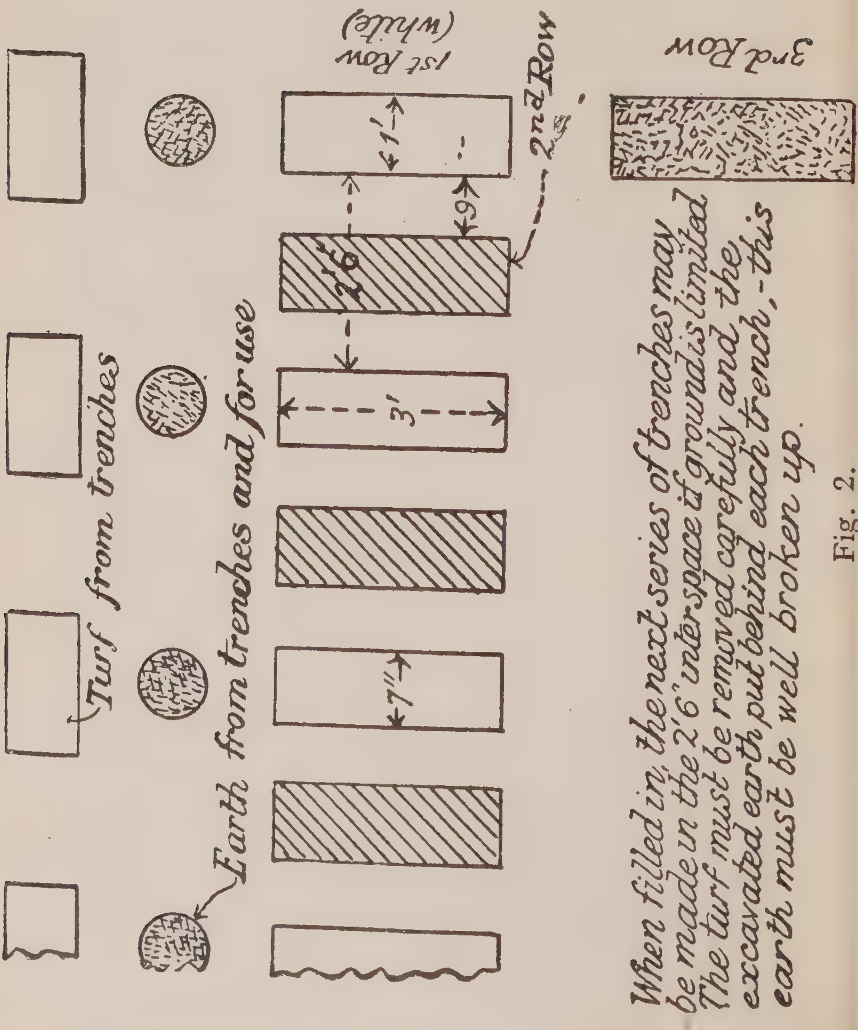

Turf from trenches
Earth from trenches and for use
1st Row (white)
2nd Row
3rd Row
1'
6"
2'6"
3'
7"
When filled in, the next series of trenches may be made in the 2'6" interspace if ground is limited. The turf must be removed carefully and the excavated earth put behind each trench, -this earth must be well broken up.

Fig. 2.

Means for preventing paper being blown about the camp must also devised. The issue of a little string will generally be all that is necessary for unused paper, but unfortunately it is generally the used paper which is found flying about.

Urinals.—The best type of camp urinal consists of a soakage pit 6 ft. cube, filled with large stones. At one end a perforated kerosene oil tin leads into the pit and serves as a urine stall. (Fig 3.)

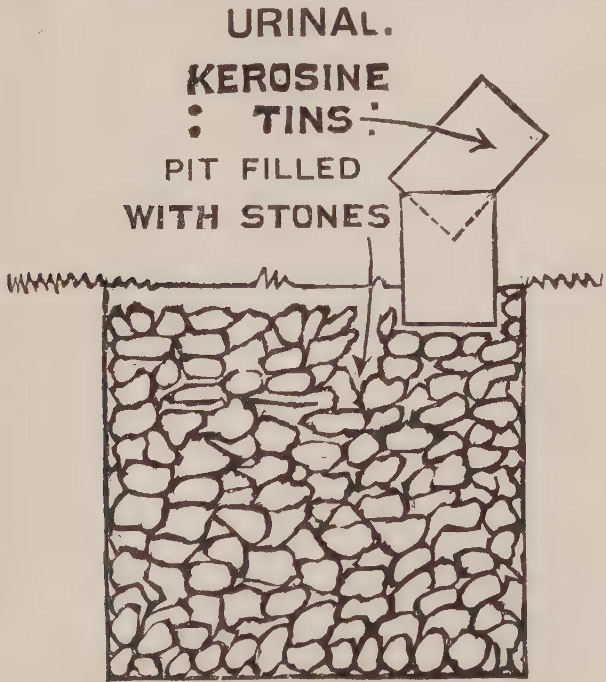
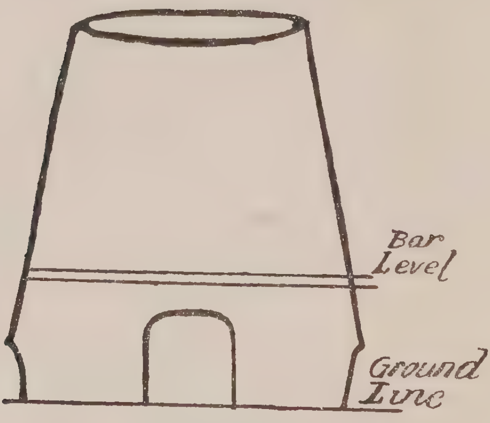


Fig. 3.

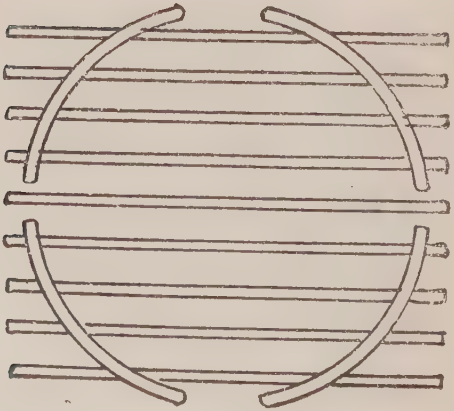
CAMP INCINERATOR.

Fig. 4.



ELEVATION.

Fig. 5.



PLAN.

Camp latrines shouldbe marked by whitewashed posts and well lighted. Where camps are likely to be occupied for any length of time, some plan for the reception of excreta in receptacles should be adopted.

Disposal of Refuse.—All waste foodstuffs, stable litter, and other refuse must be burnt. This is clearly laid down in Combined Training, but unfortunately it is not always carried out.

A most useful type of camp incinerator has been devised which can be utilised for the disposal of all animal excreta.

This incinerator consists of :—

(1) A clay dome about $2\frac{1}{2}$ to 3 feet in diameter and not more than 3 feet in height.

(2) Iron bars four feet is length to form a grating on which the fuel is placed. About 8 or 9 of these bars are required.

(3) Four ventilators for draught.

The soil adjoining most camps in India can readily be formed into rough clay bricks to form the walls of the dome.

The wall is built in four sections to a height of about nine inches, the bars are then laid on the sections and the dome completed to the prescribed height of not more than three feet.

The bars project from the side so that they can be readily removed to the next camping ground when the camp is vacated.

The construction will be readily understood from Figs. 4 and 5 which show tho elevation and plan of the incinerator.

Two sweepers should be able to build an incinerator of this type in about one hour.

The incinerator is started working by placing litter, leaves, grass or any combustible material on the bars and setting light to it.

When the furnace is working the dejecta should be placed on the top of the blazing or smouldering material.

For the adoption of this principle all excreta must be received in pans which may be improvised from kerosene oil tins if necessary.

This method of disposal has the advantage of getting rid of not only dangerous human excreta, but also stable litter and rubbish which form breeding grounds for flies.

Flies in Camp :—In a previous chapter we have discussed fully the various methods of dealing with the breeding places of flies. It is obvious, however, that in camps measures of this kind must be useless, partly because one moves about from place to place, but chiefly because, in open country, flies can travel considerable distances up to about 1,000 yards from their breeding places. The only way, therefore, in which we can lessen the "fly nuisance" in camp is by taking measures against the adult insects. This may be done in several ways, either by the use of fly papers, of which the non-poisonous varieties (such as "Tanglefoot") should be preferred, or by the use of balloon or other traps, baited with syrup or stale beer. A far better method, however, is that recommended by Hermes in 1911, which consists in taking advantage of the fact that flies

require large quantities of fluid and usually seek something to drink early in the morning. Taking advantage of our knowledge of this fact, adult flies may be easily destroyed by making a solution of 2 per cent. of formaldehyde in water and placing about the room saucers or shallow dishes filled with this solution. In order to obtain a 2 per cent. solution of formaldehyde, one teaspoonful of forformalin, as obtained from the chemist, should be added to one saucer of water. You must remember that if you allow other fluid material to remain about, then the flies cannot be expected to drink the formalin solution. But, if all other fluids are removed or covered up in the evening, the flies will greedily drink the formalin solution in the morning. After doing this they usually die within a short distance of the vessel. This solution is non-poisonous for human beings, and, therefore, there is no danger in leaving it about the house or in placing it on tables in the vicinity of food. Another simple method has been described by Howard, who states that flies can be effectively destroyed by mixing half a teaspoonful of powdered black pepper with one teaspoonful each of brown sugar and of cream. This should be placed in the room or the tent where flies are troublesome, whereupon they will quickly disappear.

The "Fly-fighting" Committee of the American Civic Association recommends the following :—

"Heat a shovel or similar article and drop thereon 20 drops of carbolic acid. The vapour kills flies." This is a method which might be adopted in the house, but it is scarcely likely to be of use for

the destruction of flies in a tent. Some authorities recommend the fumes created by burning pyrethrum powder. So far as the author's experience goes, pyrethrum powder, although it is very useful for the destruction of mosquitoes, as has been described in a previous chapter, cannot be used in sufficient concentration in living rooms to make it effective against flies.

Sunstroke.—This condition in a mild or severe form frequenty occurs during hot weather marches in the Tropics. Medical men are not quite agreed as to the cause of the condition. No fewer than four theories as to the cause of sunstroke have their adherents.

Alcohol is distinctly conducive to sunstroke, and it should therefore never be partaken of when on the march.

The classical symptoms of an acute case are sudden insensibility with flushed face and convulsions, but there are many degrees far short of this in which the man only turns pale and faints or complains of giddiness or dimness of vision.

The treatment of the condition is :—

(1) Undo all clothing. (2) Remove the patient to a cool shady spot. (3) Strip him to the waist. (4) Lay the patient down with the head and trunk well raised. (5) Procure as free a circulation as possible of fresh air, and fan the patient vigorously. (6) Apply ice bags or cold water freely to the head, neck, and spine, and maintain this treatment until the symptoms subside. (7) On return to consciousness, the patient may have a drink of water.

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